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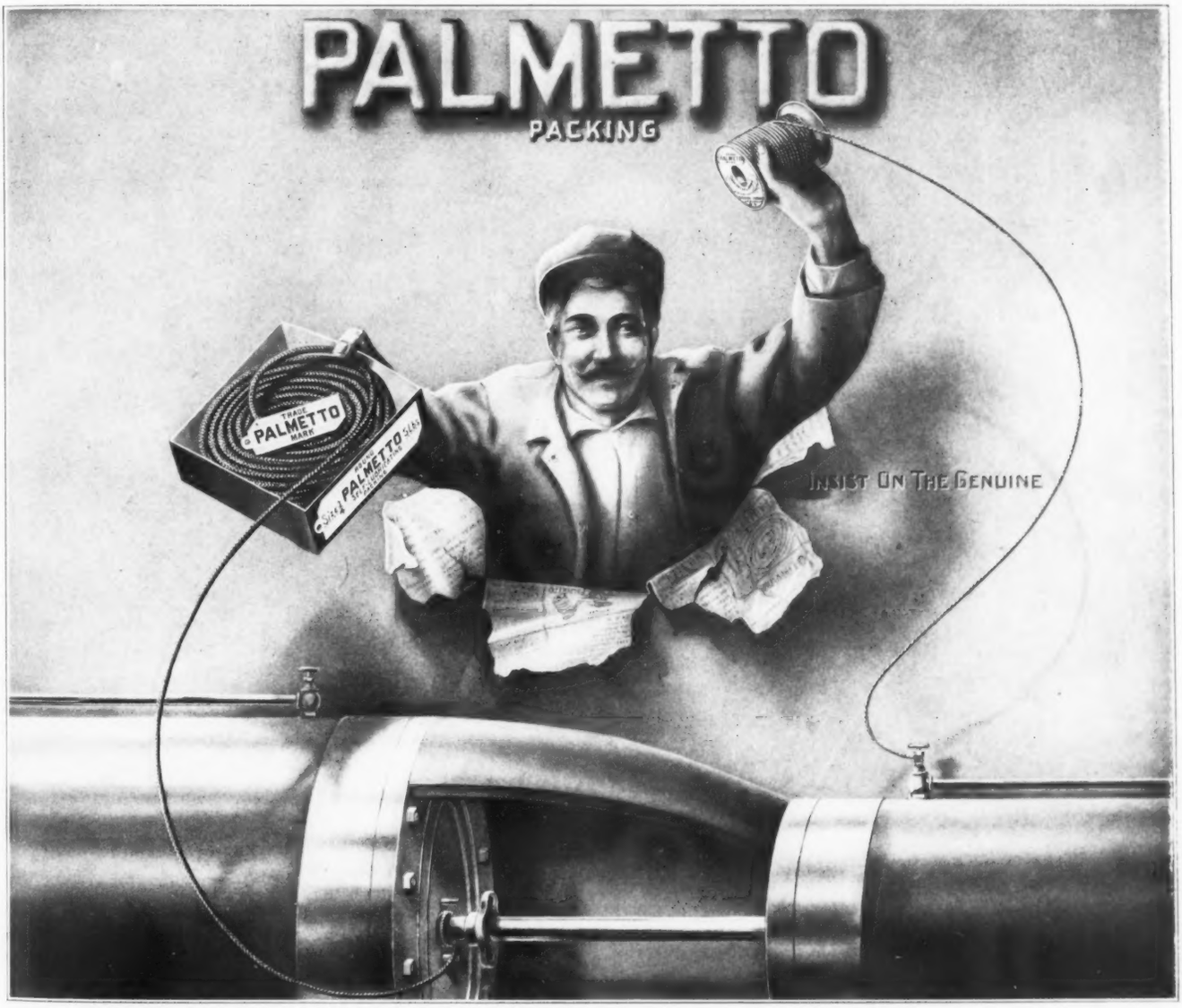
# POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29. Index to Advertisers and Classified Index Following Reading Matter No. 9.




## THROUGH THE PRINTED PAGE WE REACH YOU.

We would prefer calling on you and having a quiet chat in the engine room, but we cannot do so at once, and feeling that you may be dissatisfied with the piston rod packing you are now using, we draw your attention to PALMETTO PACKING and explain to you that it differs widely from all other piston rod packings, both in material and methods of manufacture, because heat cannot destroy the substance of which it is made, and by reason of a painstaking method of manufacture it does not harden in service.

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**And remember**—these results were obtained after the Insurance Inspector reported the boilers as being **clean.**

Here's the story as told by a consulting engineer who is an entire stranger to us:

firemen can
or against firem
knowledge.

5th. Bad Water. This generally means scale or corrosion and the accounting system detects both, the first by falling off in evaporation and the second by an increase in repairs. As an example the writer knows a plant having four 150-h. p. return tubular boilers installed, operating 24 hours per day, which were pushed to their utmost to furnish the necessary steam, and the insurance inspectors after their examination reported the boilers as being clean. At about this time an enterprising salesman arrived with a good tube rattler which he induced the management to buy. This was put through the tubes and scale taken out by the bushel, the result being that they are now easily operating their plant on only three of the boilers. Had a good accounting system been in use the boilers would have never gotten into such condition and the fuel saved would have been enormous.

6th. Leaky Boiler Settings. This would result in a
ss of evaporation and could be detected by $CO_2$ r
der and incop ue temperatures. Th
gen lly un
ab

A. M. Allen, Consulting Engineer, In "Electric Traction Weekly" May 7, 1908.

Vulcanized Rubber Company, Morrisville, Pa.

The Dean Boiler Tube Cleaner.

NOTE:
We obtained these facts through correspondence after we read Mr. Allen's paper.

You can't get around the logic of the foregoing. If you've got scale it's costing you money. Because you think you haven't any scale, or because an Insurance Inspector tells you so, isn't an indication that you haven't any.

Don't you want to know whether or not you have scale? Or which cleaner will do the most thorough work?

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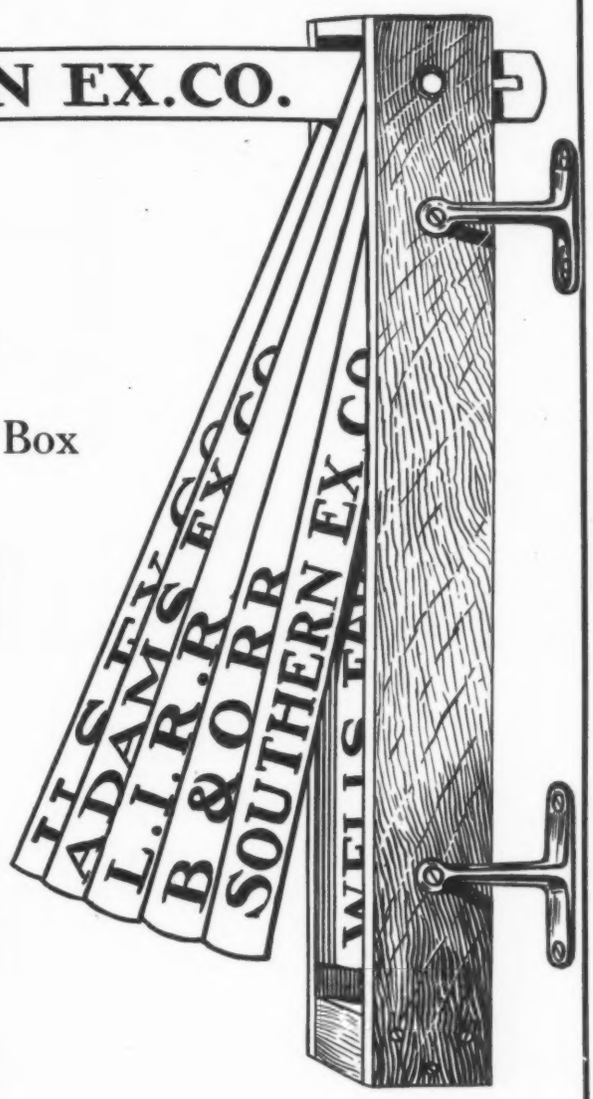


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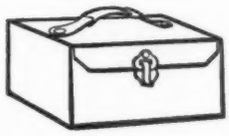

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Sept. 1, 08, Dept. B

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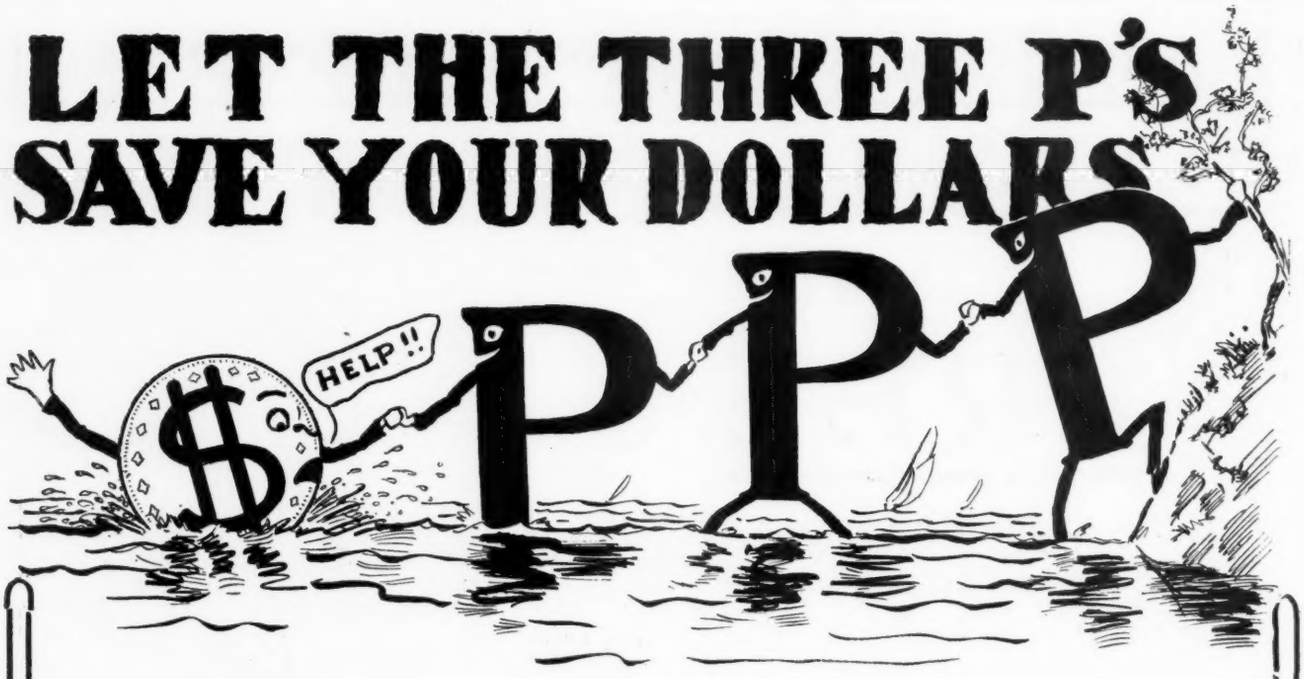


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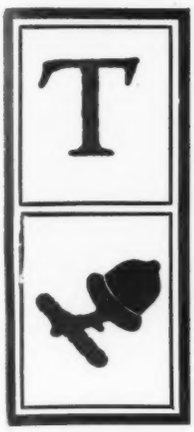
# The House of Dearborn



THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

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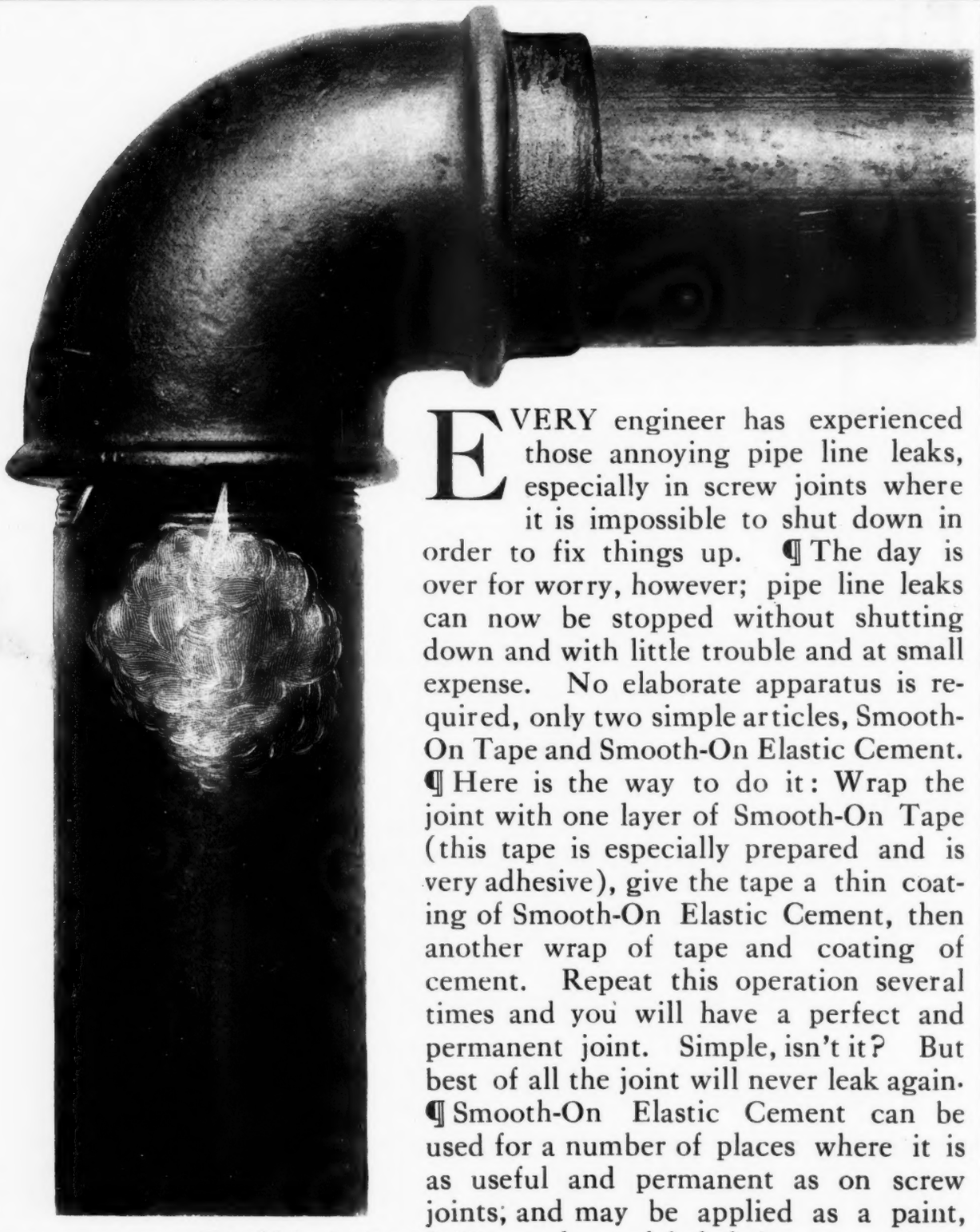

EVERY engineer has experienced those annoying pipe line leaks, especially in screw joints where it is impossible to shut down in order to fix things up. ¶ The day is over for worry, however; pipe line leaks can now be stopped without shutting down and with little trouble and at small expense. No elaborate apparatus is required, only two simple articles, Smooth-On Tape and Smooth-On Elastic Cement. ¶ Here is the way to do it: Wrap the joint with one layer of Smooth-On Tape (this tape is especially prepared and is very adhesive), give the tape a thin coating of Smooth-On Elastic Cement, then another wrap of tape and coating of cement. Repeat this operation several times and you will have a perfect and permanent joint. Simple, isn't it? But best of all the joint will never leak again. ¶ Smooth-On Elastic Cement can be used for a number of places where it is as useful and permanent as on screw joints, and may be applied as a paint, paste or putty. ¶ Sold in 1, 5 and 10-pound gray labeled tin cans. Don't forget we make Smooth-On for all purposes for use around the power plant —there is hardly a repair where Smooth-On cannot be used to advantage.

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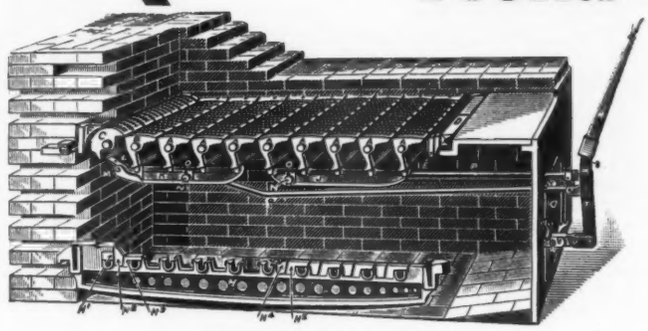
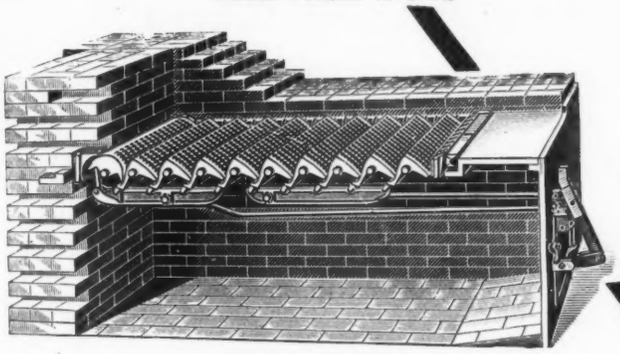
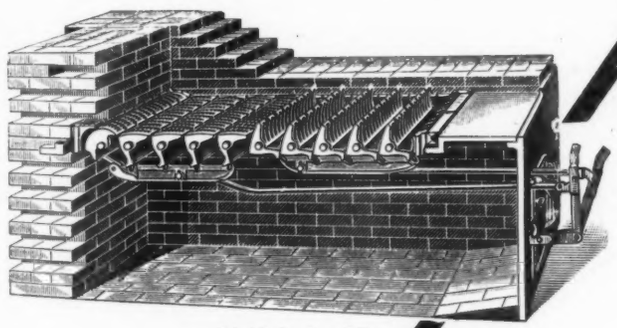


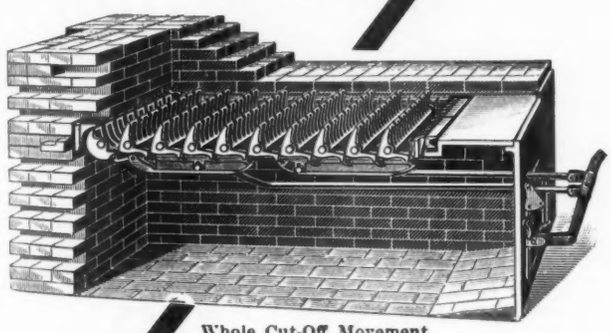
Normal Position of Grate



Shaking Movement



Divided Cut-Off



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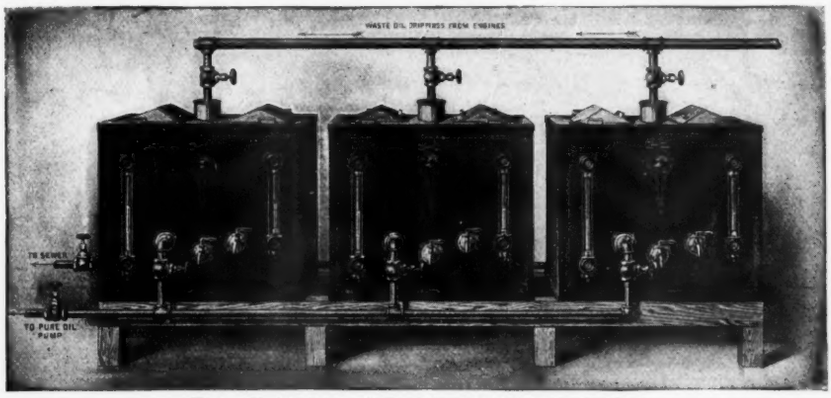
# Burt Unit Oil Filters

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# Simple Forms of Coal and Ash Conveyers

## Descriptions of Several Types, Some Hand Controlled and Others Requiring Machinery, Showing How They Are Constructed and Operated

BY WARREN O. ROGERS

The object of this article is to describe and illustrate several types of coal and ash conveyers, a knowledge of which may help engineers who contemplate designing systems for their own plant.

A simple type of coal conveyer is shown in Fig. 1. It consists of a truck placed

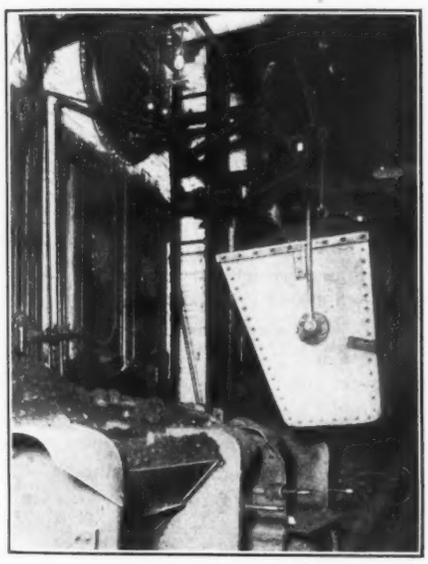

FIG. 1. TROLLEY BUCKET CONVEYER

on brackets of such dimensions as will bring the dumping bucket in a position over the furnace hoppers for filling without scattering the coal over the floor of the boiler room. This is about the most simple type of conveyer in use. It is most suitable for places where the space in front of the boilers is restricted. As shown, the system consists of a bucket suspended from a hook attached to a frame piece supplied with two flange wheels which run upon the track. The bucket is supplied with a locking dog, which prevents the bucket from tilting, until the dog is knocked out of place by the coal passer, when ready to dump the coal into the hopper. The bucket is pushed, by the men employed in the boiler room, to the coal supply, where it is filled by hand and pushed back over the empty hopper. The dog (not shown) is then knocked up, and the fireman, after climbing up on top of the hopper, trips the bucket, its contents going into the hopper.

With this method of handling coal it is evident that a good deal of manual labor is required in pushing, filling and dumping the bucket. Such an installation does not cost very much and with a small battery of boilers is probably as suitable as any arrangement that could be installed at a small cost.

The arrangement of the conveyer system shown in Fig. 2 is a slight improvement over that shown in Fig. 1. In this case the coal is stored in a bin under the sidewalk, and runs into the coal bucket shown suspended before the boiler while resting on the car shown upon the track which extends to the coal tank. When full, the car with its bucket load of coal is pushed before the hopper to be filled and the bucket lifted to a position above the hopper by means of blocks suspended from a small traveling crane that can be moved out nearly to a position over the car. The coal is delivered to the hopper through the bottom of the bucket. This system is suitable where the space under the coal-storage tank is restricted.

### Proposed Conveyer System

In Figs. 3 and 4 are shown the proposed plans of a simple conveyer system.

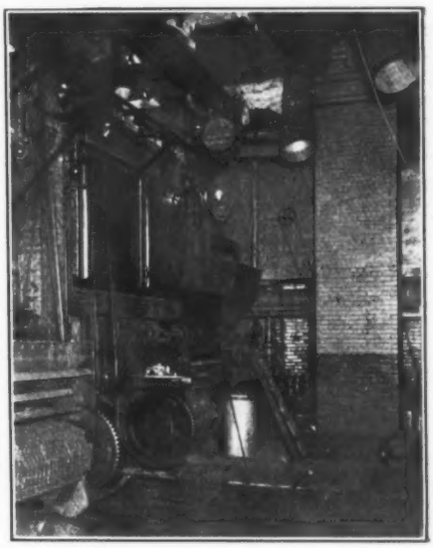

FIG. 2. BUCKET AND CAR CONVEYER

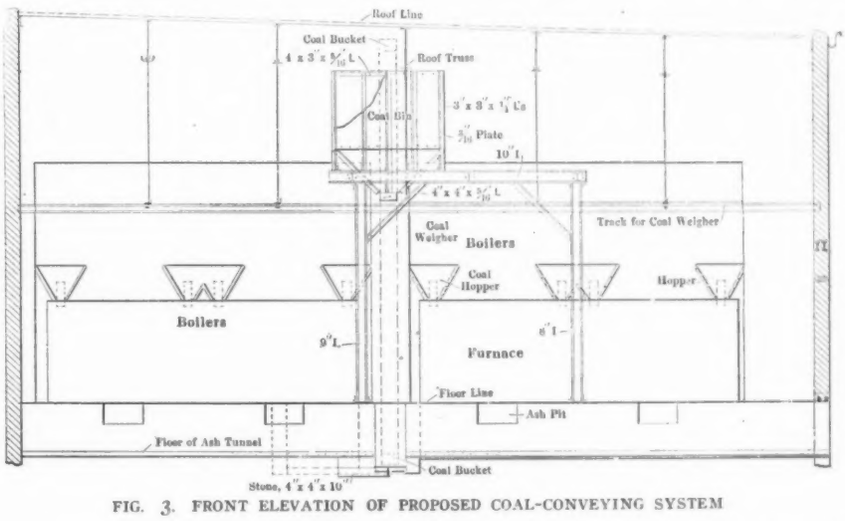


FIG. 3. FRONT ELEVATION OF PROPOSED COAL-CONVEYING SYSTEM

At present the coal is delivered to the boiler room in coal cars drawn up an incline on to an elevated trestle, which will be described later on. Fig. 3 shows a front elevation, Fig. 4 a side elevation. In this instance, the ordinary type of bucket conveyer is included in the design and is to be driven by either an electric motor or a steam engine. The coal car is to be drawn up over the coal pocket under which the coal crusher shown in Fig. 4 is located. The conveyer buckets pass under the outlet and convey the crushed coal to the coal bin shown in Figs. 3 and 4, which slants in at the bottom, thus permitting the coal to fall freely into the weighing scale directly underneath. The flow of the coal to and from the scale is controlled by valves.

The coal passes from the scale to the desired hopper, the scale being fitted with rollers operating on a track, to permit of moving it from one hopper to another.

The ashes are to be handled by means of a car operating independently of the conveyer system. The ashes falling into the ash pit are to be raked into a car standing on a track, and then removed. No dimensions have been given in this case, as the system is of special design and fitted for this particular plant. The idea is there and can be modified or enlarged upon to suit individual conditions.

The present method of handling coal supply is shown in Fig. 5 and illustrates what a home ingenuity can do. The carload of coal is drawn up an incline track to a point over the coal bin, which extends the entire length of the fire room. The coal is then dumped into the bin through the bottom of the car.

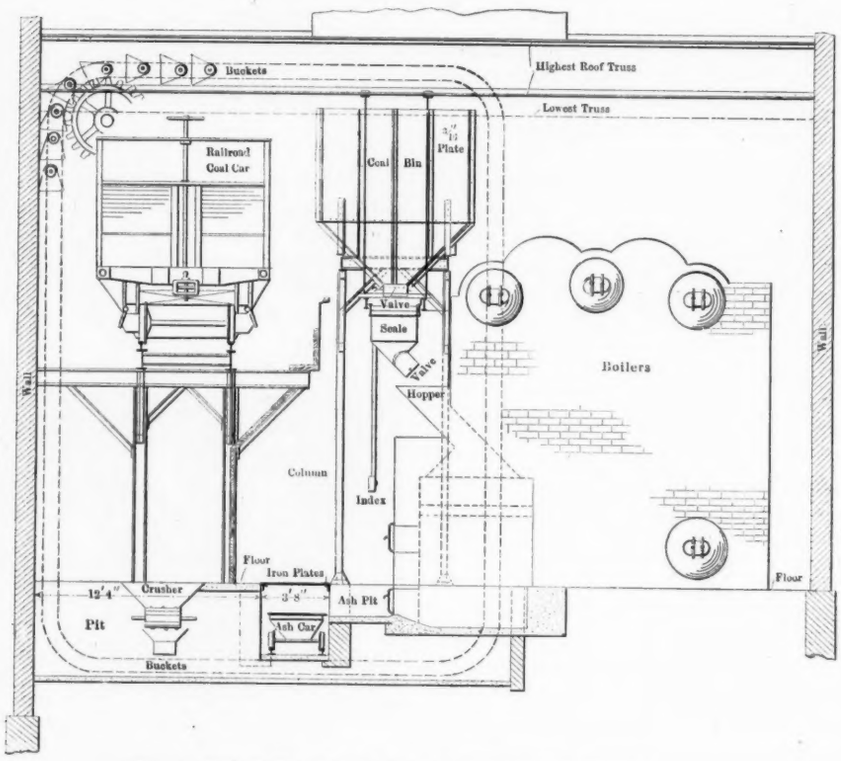


FIG. 4. END ELEVATION OF PROPOSED CONVEYER SYSTEM

The hoisting operation consists of a second-hand, double-cylinder upright engine, the crank shaft being located above the cylinder. A belt wheel is placed on the engine crank shaft and belted to a 4-foot belt wheel on a winding wrench. The end of the pulley shaft is fitted with a small gear wheel which meshes into a 30-inch gear, having its teeth on the inside of the rim. The shaft on which the gear is fitted also contains a 20-inch sprocket wheel, over which a sprocket chain fits, the chain being fitted to a similar sprocket wheel on the winding drum located in the boiler room. The winding drum is constructed with a gear wheel at one end, which meshes into a small gear mounted upon the shaft supporting the sprocket wheel. A double-wire cable is attached to the drum at one end and to a car of coal at the other, when the storage bin requires replenishing. When all is ready, the fireman pulls the rope *A*, shown in the reverse view of the winding wrench. This lifts the lever, which, in turn, revolves the cam *D*, thus lifting the arm *E* and loosening the brake *F* on both sides of the brake wheel. At the same time the throttle is opened by means of the lever *C*. When the car has been pulled to its destination, the rope *B* is pulled and draws the lever *C* down, closing the throttle valve on the engine and turning the cam *D* back to its original position, thus allowing the weight on the arm *E* to tighten the brake *F*. The last two systems were designed by F. W. Ballard, Cleveland, O.

### Simple Ash-Handling System.

A simple method of handling ashes is shown in Fig. 6 and is an idea worked out by C. E. F. Ahlon, of Cleveland, for a proposed steam-plant installation. It consists of a trackway suspended by hangers attached to the side of the building, as shown.

The bucket *A* rests in a pit, into which the ashes from the grates fall, the bottom of the ash pit proper being made on a slant. When the bucket *A* is full, it is hoisted up above the fire room by means of the chain blocks. The bucket of ashes is then pushed along the track and the ashes dumped either into a wagon or flat car and removed. By this method the ashes are not handled by hand, with the exception of a few scatterings.

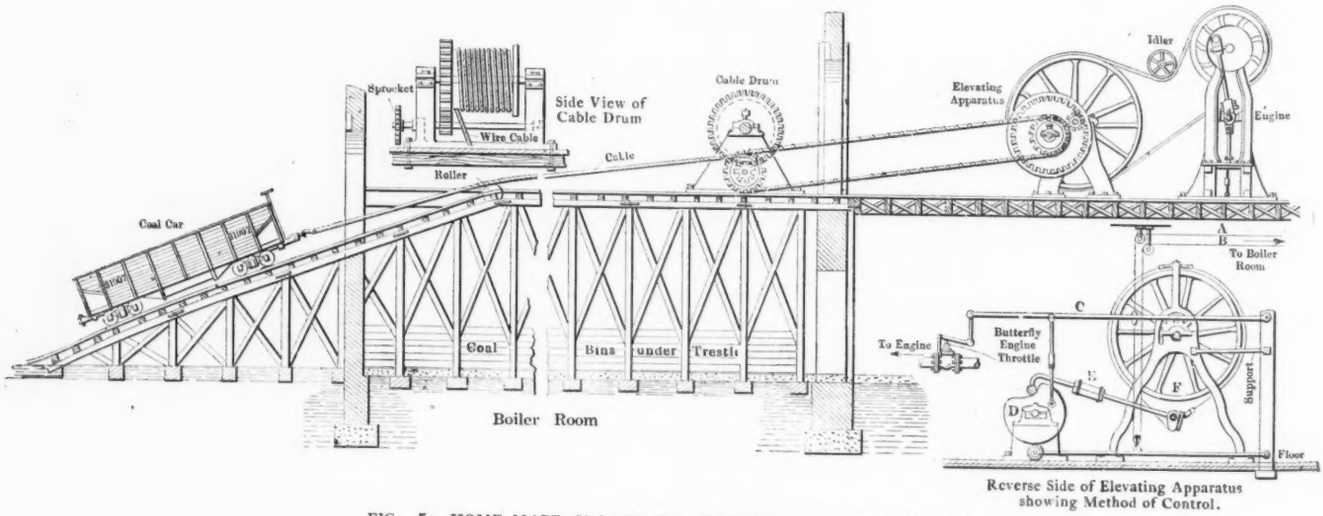


FIG. 5. HOME-MADE SYSTEM FOR HANDLING THE COAL SUPPLY

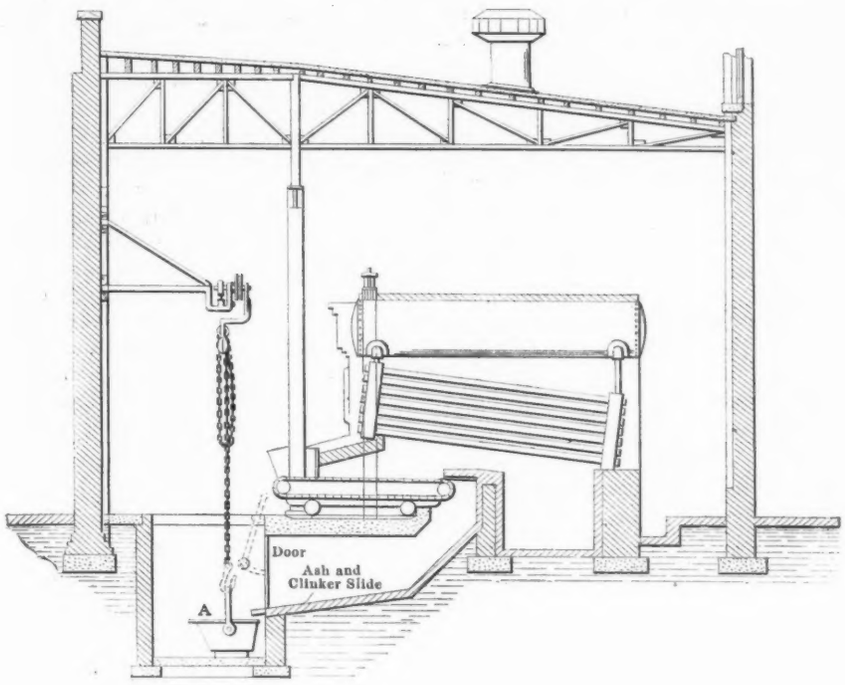


FIG. 6. SIMPLE METHOD OF HANDLING ASHES

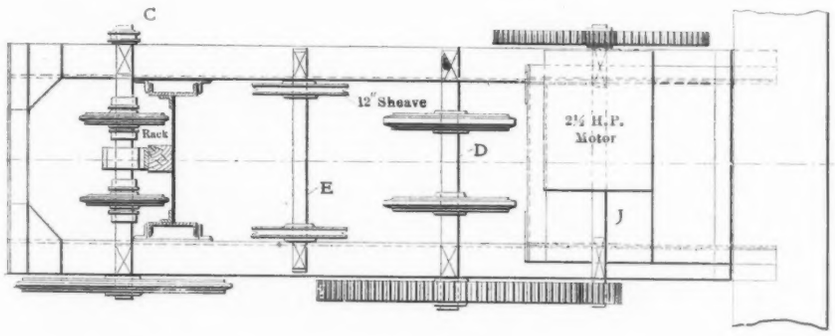


FIG. 8. PLAN OF WHEEL AND GEAR ARRANGEMENT

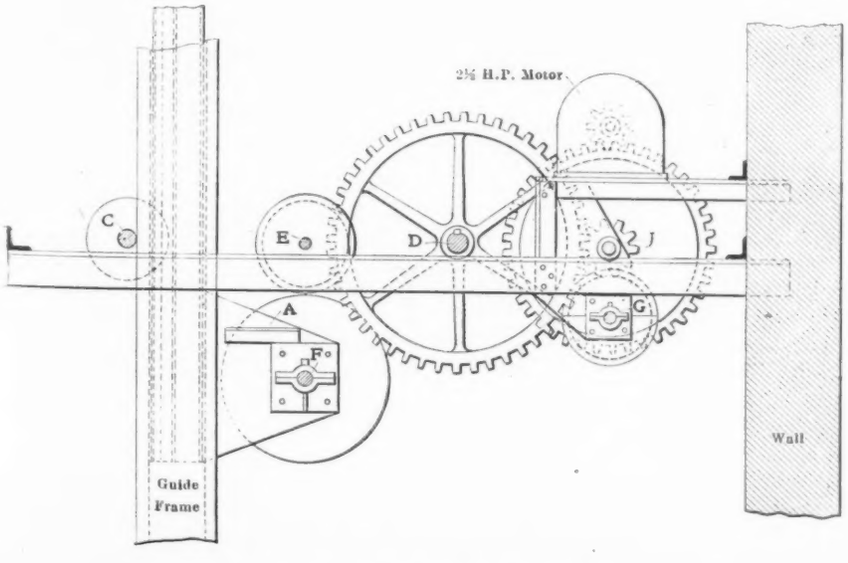


FIG. 9. SIDE ELEVATION OF THE GEARING

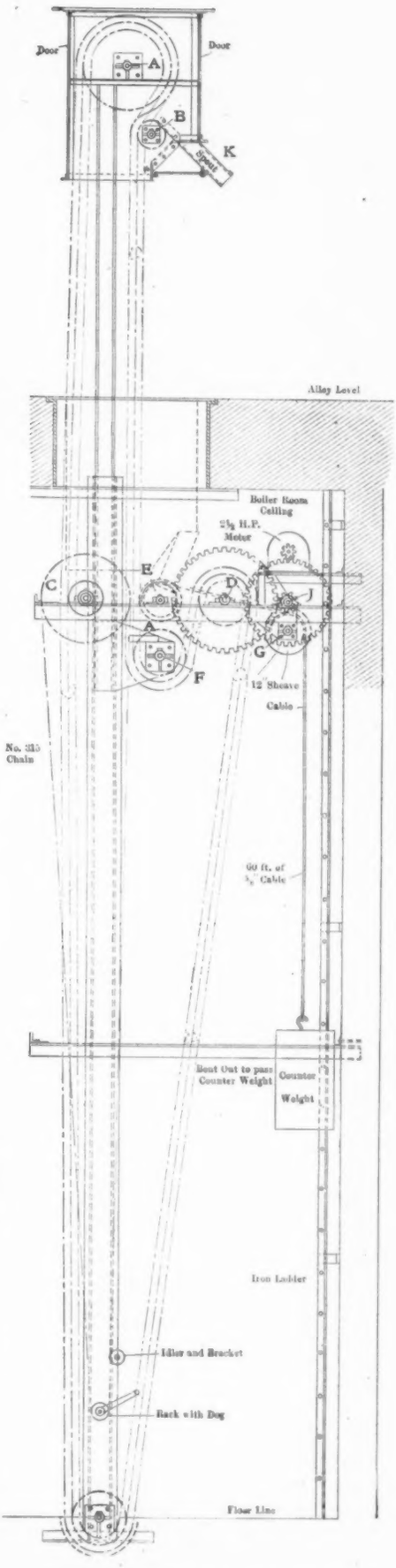


FIG. 7. DISAPPEARING COAL ELEVATOR

The quick and convenient handling of clinkers and ashes has come to be an important problem for engineers. In no place are the difficulties greater than in the power plants required for the large office buildings now so common in all of our large cities. Fig. 7 illustrates a disappearing elevator used for elevating such refuse in an office building and discharging it directly into wagons.

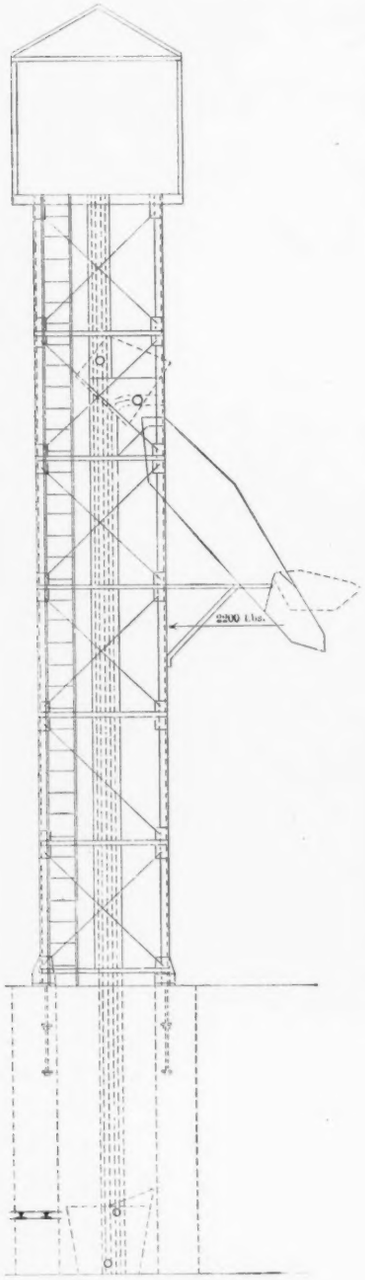

FIG. 10. SKIP ASH HOIST

The elevator is made telescoping and with sufficient counterweight to maintain the head in any position of its travel. A small electric motor furnishes the power for operating. The ashes are dumped into the elevator boot. After folding the discharge chute the elevator head may be dropped flush with alley level, forming the cover for the opening in the pavement.

It will be seen that when it is desired to remove the accumulation of ashes, the counterweight is drawn down, which causes the extension to rise to the position shown, the 5/8-inch cable being attached to the plane work at the point *A*. As the extension drops, the wheel *F* drops also and so maintains a proper tension on the conveyer bucket chain. The ashes are hoisted from the ash pit below the floor line and delivered to the wagon provided for the purpose of removing them, through the spout *K*.

A plan view of the gearing supporting and operating the buckets is shown in Fig. 8. In Figs. 8 and 9 the letters *C, D, E,* etc., are for the purpose of locating each wheel in the two illustrations.

For still more complete automatic operation, Fig. 10 illustrates an electric skip hoist, the operation of which requires only a push button. When the button is pressed the motor is started, carrying a loaded skip to the top, dumping and returning it automatically to the bottom position ready to receive another load.

The skip is attached to two cables, one at the top, the other at the bottom. When the skip is to be dumped, the bottom cable lifts the bottom of the skip, as shown by the position of the skip in dotted lines. The ashes are dumped into the spout and run down into the cart or car, as the case may be. The ash hoists shown in Figs. 8 and 9 were designed by the C. O. Bartlett & Snow Company, Cleveland, Ohio.

## New Power House at West Port

By Edward T. Binns

A new power plant, finished and running with all the smoothness and satisfaction of an old station is an attraction indeed. Such an installation is the West Port station of the Consolidated Gas, Electric Light and Power Company, of Baltimore A general view of the building is shown in Fig. 1 and also the steel trestle for the conveyers which carry the coal from barges to the bunkers above the boiler room. Some idea of these bins can be gained from Fig. 2, an interior view showing the reinforced concrete construction.

The engine room is equipped with five cross-compound engines built by McIntosh, Seymour & Co., of Auburn, N. Y. Four of these units are shown in Fig. 3. All are direct-connected to General Electric 2000-kilowatt generators and are of the vertical type, running condensing. The condensers are of the elevated-jet type,

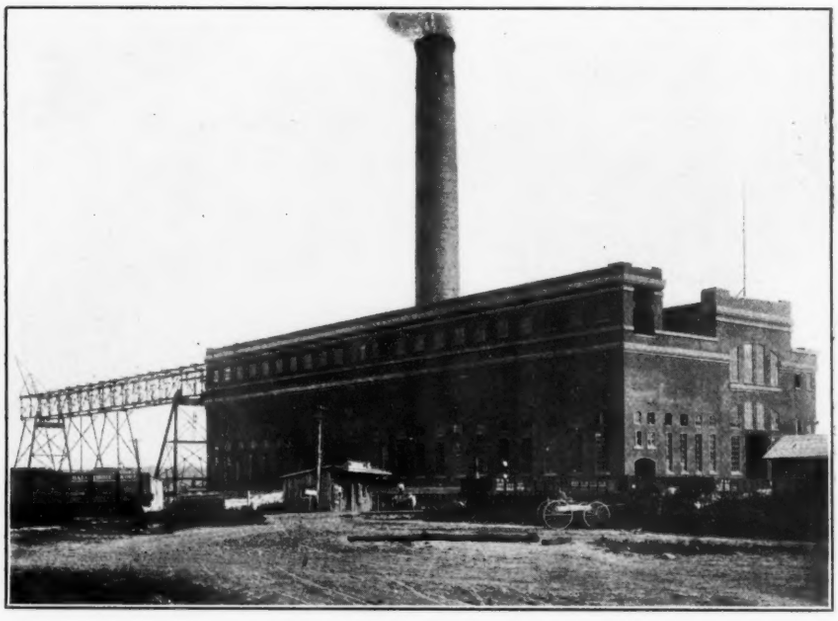

FIG. 1. THE PLANT AT WEST PORT

and are plainly visible in the photograph. Thermometers, placed side by side, indicate the temperature of the circulating water, before and after passing through the condensers, and usually show a rise in temperature of only 8 or 10 degrees. In starting, the vacuum is formed by a Worthington dry-vacuum pump located in the basement. The circulating pump and main engine are then started, and the dry-vacuum pump shut down. The circulating pumps are of the centrifugal type and are driven by vertical steam engines, also in the basement.

Four of the engines are 33x68x56-inch and run at 94 revolutions per minute. The

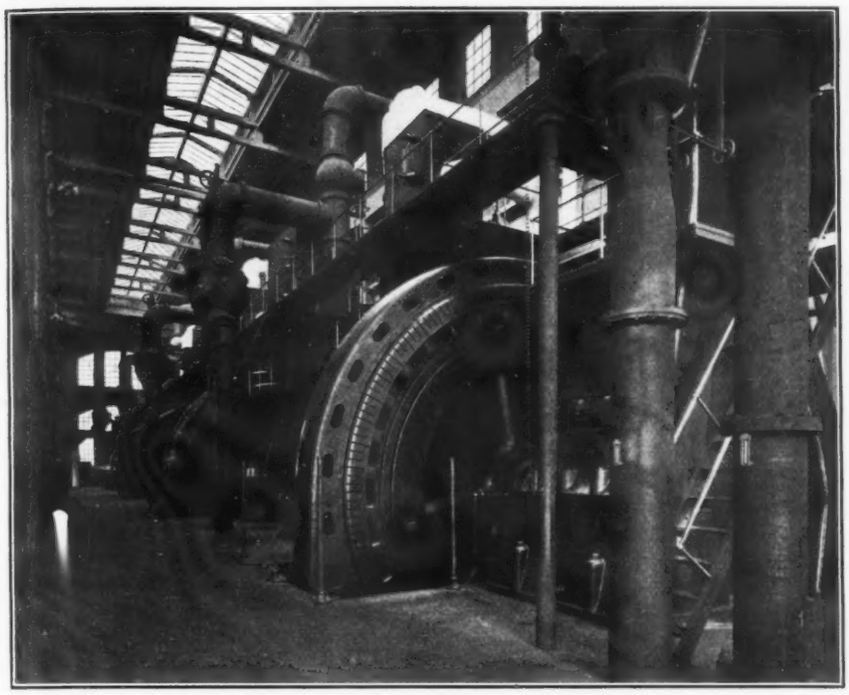

FIG. 3. FOUR OF THE CROSS-COMPOUND VERTICAL UNITS

FIG. 4. BOILER ROOM DURING INSTALLATION PERIOD

FIG. 2. REINFORCED CONCRETE COAL BIN

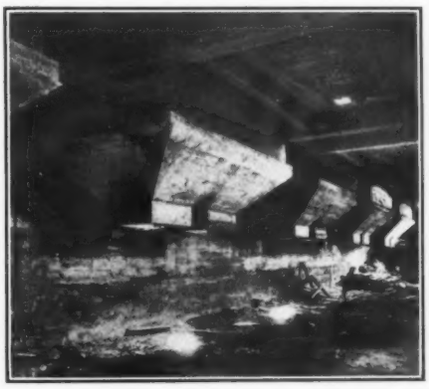

FIG. 6. ASH HOPPERS

fifth engine is of the same make, but is a twin angle-compound, 38x78x56-inch, direct-connected to a 7000-kilowatt alternating-current generator. The crank shafts on these engines are 18 inches in diameter and hollow. No trouble is reported from hot bearings. An automatic oiling system, or rather an air-pressure oiling arrangement, is provided, and a pressure of 60 pounds is maintained.

The boiler-room equipment consists of 14 Babcock & Wilcox water-tube boilers, with superheaters delivering steam to the engine room at 450 degrees superheat and 180 degrees pressure. All coal is bought on the analysis basis, and it is let down to the boiler room by means of the hand-thrown traps shown in Fig. 4, which was taken before the boiler room was completed, but shows the tracks from which are suspended several traveling chutes, each having a capacity of one ton. The boilers are all hand-fired.

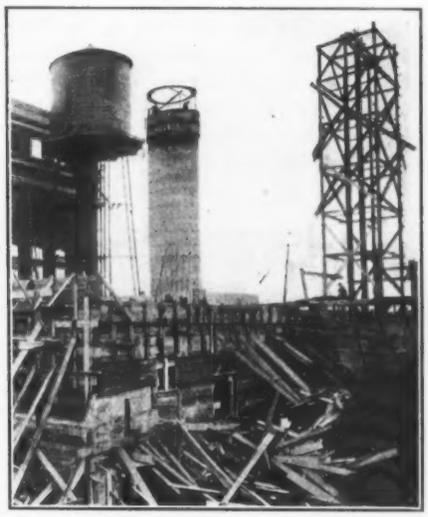

FIG. 5. ERECTING CONCRETE STACKS

The station is near the river where there is no scarcity of water. Fig. 5 shows one reinforced-concrete stack in process of construction, and the scaffolding for another, also a wooden water tank. The day after this picture was taken, every hoop on the tank burst, letting most of the material and all of the water come to terra firma. The cause was assigned to the hoops being drawn too tightly while the material was dry. Fig. 6 illustrates the arrangement for dumping the ashes into cars on a small railroad provided for carrying them to the boat. General Electric horizontal steam turbines are used to drive the exciters. The main current is sent out of the station at 13,000 volts.

The company is running an exhaustive series of efficiency tests on this and some other installations of different character and promise some interesting figures later on. Thus far, the West Port plant has produced current with 2.69 to 2.89 pounds of coal per kilowatt-hour.

# "Moisture" and "Expansion" Packings*

## The Causes Responsible for Their Adoption; How Rubber Packing Is Made, from Gathering Sap to the Completed Product; How Developed

BY W. E. SANDERS

The term "moisture" is used for lack of a more descriptive name. Really, flax packing, generally used as a monkey-wrench packing, ought to be used as a moisture packing, and under any circumstances depends upon the moisture for a large part of its efficiency. On the other hand, some moisture packings involve the use of rubber, and when used on hot water or steam are really "expansion" packings.

When a flax packing is used on a pump, the moisture is soaked up into the flax and expands it, thus producing the desired pressure against the rod. This is common pump practice. If square duck is used, the cut ends of the cotton fibers absorb moisture and swell and cause a similar pressure against the rod. To this extent it is a moisture packing.

For some time it has been considered

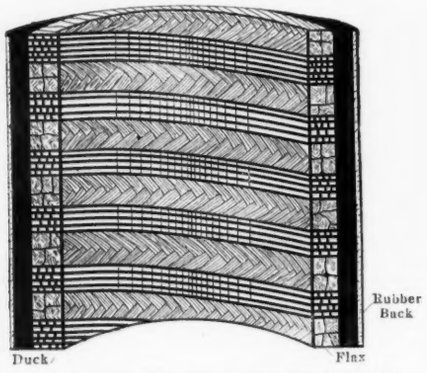


FIG. 1. SQUARE FLAX AND DUCK WITH RUBBER BACK

good practice to alternate square flax with square duck. The flax swells and does most of the packing, while the duck braces up the flax and stands the bulk of the wear and tear. This is current practice today, both on rods and pistons. This packing was further developed by cementing the flax and duck to a rubber back, which has the additional advantage, when used with hot water or steam, in that the rubber back is expanded by the heat and presses the packing against the rod with an easy elastic pressure. When no heat is present the expansion of the rubber, if any, must be produced by pressure from the gland. In its best form this packing is made into sleeves of sufficient size so that the box will be filled with two or at the most three pieces. It is also made into coil form.

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There is an objection to this packing when used in coil form. The cementing of the cotton duck edgewise to the rubber back is not an easy operation, and under the influence of heat, which weakens the cement, and the back-and-forth action of the rod, the duck sides will become detached. To overcome this defect recourse has been had to home-made packing. Engineers have often split old water hose in two and placed square flax inside. A packing is now made in practically this form. The advantages of the rubber back are lost, but are more than com-

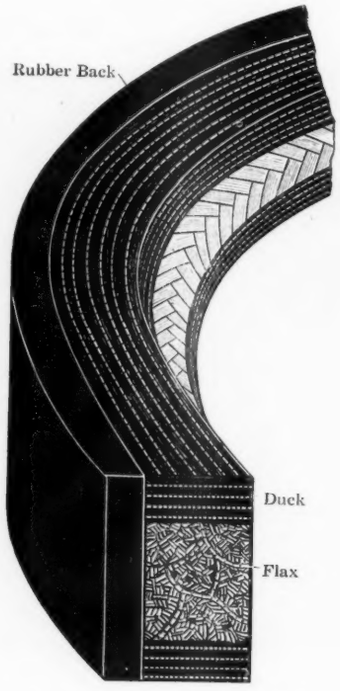



FIG. 2. RUBBER BACK, DUCK SIDES AND FLAX CENTER

pensated for by the increased life of the packing, which is tough and durable and at the same time flexible and easy on the rod.

Such a packing as this is especially useful for water, and with large vertical plungers may be put in so that the flax faces toward the cylinder, in which case it acts like an hydraulic plunger ring, the pressure of the water expanding the ring against the rod, with the resultant effect of a very tight packing. This packing will work satisfactorily without using a wrench, and yet many engineers by force of habit or ignorance will use a wrench with bad results to both packing and rod. The packing is good for any case where moisture is present in the form of water, oil or steam that has not been superheated before entering the cylinder, and naturally is a capital packing for low pressures of ordinary steam and especially for all classes of pump work.

### Expansion Packings

The foregoing classes of packing produce an unnecessarily excessive pressure on the rod, especially when ignorantly or negligently used. Unnecessary pressure means unnecessary friction and unnecessary load on the engine, and also a much more rapid wearing down of the rod. Consequently engine builders began to pay more attention to details and the era of expansion packing began. This word "expansion" is abused by packing manufacturers and we limit it to the meaning of a packing which expands as the tempera-

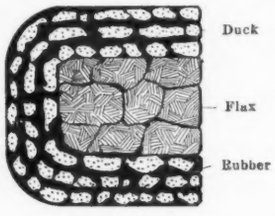



FIG. 3. A PACKING FOR LOW-PRESSURE AND PUMP WORK

ture increases. This is a physical characteristic of rubber, and if a packing entirely of rubber were used, it would furnish the best example of expansion packing. For ordinary purposes, however, there is too much expansion and it is better to add to the rubber some fiber, such as cotton cloth. The first packing of this sort was in all probability during the sixties or seventies and was cut from a rubber belt, which is made of alternate layers of cloth and rubber with rubber covers on the outside. It was used with the cloth placed edgewise to the rod.

### The Manufacture of Packing

Packing involves certain technical terms which are not so necessary to a clear understanding as they are confusing if they are not understood. A general outline of the manufacture of packing will help in this regard and in this outline an explanation will be given of the terms

"friction," "vulcanization" or "cure," and such other terms as may occur.

The best crude rubber is obtained by the natives at the sources of the Amazon in a way very similar to that used in obtaining maple syrup or turpentine. The sap is collected in large storage bowls, and into this liquid paddles are dipped and held over the smoke of a fire, thus in a rough way drying the sap in successive layers until an elliptical ball about 20 inches long and 12 inches in diameter is obtained. This ball is cut in two and shipped to the United States as a rubber "biscuit." Other grades of rubber are obtained in practically the same way, the difference being in the locality or trees from which it is obtained and the methods used in drying.

This biscuit when received at the factory, is first sheeted and washed, that is to say, it is thrown in between two horizontal rolls, one of which revolves more rapidly than the other, the second roll being slightly corrugated. This tears the biscuit apart into the form of a sheet which is about 10 feet long and 2 or 2½ feet wide. During this process water is constantly poured upon the rubber to wash away the grosser impurities. The sheeted rubber is then dried thoroughly, as it is impossible to make rubber stick to anything if moisture is present.

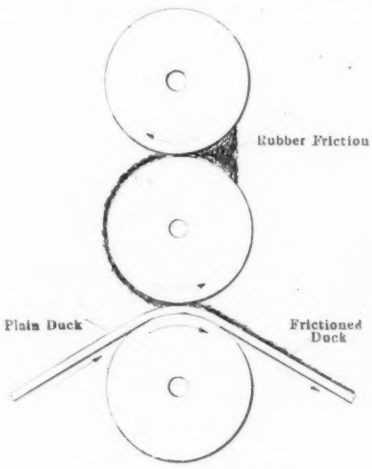



FIG. 4. CALENDER ROLLS

Very few packings, if any, are made of pure gum. There are two reasons for this. One is the fact that if packings were made of pure gum the limited supply of rubber would make the price of the packing too expensive. Another reason, which is more important, is the fact that pure gum would seldom fulfil satisfactorily the conditions of packing. For example, pure gum will absorb ammonia and swell to an almost incredible extent, so that if it were used as an ordinary ammonia gasket, it would swell into the interior of the pipe line, and, becoming detached, would clog up the small needle-like expansion valves, with the result that the whole system would have to be shut down to clear the valve. It is clear that pure gum would not do where it has to come in direct contact with ammonia, and for this reason male and female couplings are devised in such a way that the rubber gaskets cannot reach the inside of the pipes.

On the other hand, certain compounds can be made, and nearly every rubber manufacturer has such compounds, which will be but slightly affected by ammonia, if at all. The rubber in these compounds acts as cement in concrete, and the value of a compound depends generally on the materials that are held together by the rubber rather than on the amount of rubber in the mixture, just as the comparative values of several foundations, all made with portland cement, depend upon whether cracked stone, brick or gravel is used. One of the very essential things then in packing is the compound, which must be suitable to the service for which the packing is to be used A packing which is excellent for oil may be very unsatisfactory for steam, and a packing which is unexcelled for steam may be useless when in contact with ammonia.

After being dried the crude rubber is mixed with the various ingredients that enter into the compound desired. This mixing is done on a mill very similar to the machine used for sheeting and washing the crude rubber, except that there are no corrugations and no water is present. The various ingredients are thrown into this mill and worked backward and forward and over until the whole is uniformly mixed.

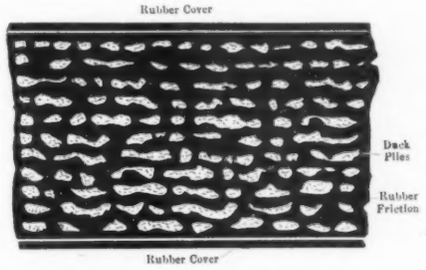



FIG. 5. HYDRAULIC PACKING

While the rubber has been going through this process, a roll of cotton duck has been successively run over steam-heated rolls until all the moisture has been driven out of it. This is then run through a calender consisting of three rolls arranged vertically. The duck is passed over the lower roll, and the raw mixture is placed between the two upper rolls. As the middle roll revolves it carries the compound and rubs it into the cloth on the lower roll. As the middle roll revolves at a faster speed than the lower one, the action is not merely pressing in, but actually rubbing in, and so great is the effect that the raw stock is actually rubbed through the fibers and may often be seen appearing on the opposite side of the cloth. This batch is called "friction," and cloth that has been so treated is called "frictioned cloth." The cloth is frictioned on both sides and is then run out on a long table and cut into diamonds. The diamonds are turned one-quarter way around, which brings the cut or bias edge on the outside, and a second set of diamonds is placed on top of the first set, but turned in the opposite direction. Successive layers are thus placed on each other until a "slab" is built.

It is now necessary to explain "vulcanizing." When the raw stock comes from the mill it has a stickiness or "tack" to it, and more than this, it is plastic. A small portion of it could be rolled up into a ball and would stay in that shape. To obviate these undesirable qualities a substance, which is generally in the form of a powder and will vulcanize rubber, is thoroughly mixed throughout the whole batch, and the batch is subjected to heat. The vulcanizing substance will act on the rubber, with the result that the compound will lose its tack or stickiness and is no longer plastic. If a piece of it be rolled up in the hand, it will return to its original shape when released. The vulcanizing process requires skill and long experience, and is so delicate an operation that even conditions of season or of the weather must be taken into consideration. If rubber is under-vulcanized, it will still retain some of its tack and some of its plasticity. If it is over-vulcanized, it will be hard and brittle, that is, it will crack easily; but if properly vulcanized or "cured," it will not crack even when doubled back on itself, and will be elastic, the amount of elasticity depending very much on the amount of rubber in the compound.

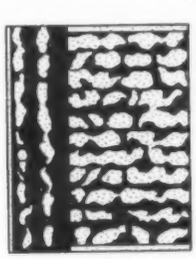


FIG. 6. DUCK PLIES REINFORCING RUBBER

The slab previously referred to is practically layers of cloth with friction between the layers, and when this slab is compressed to the proper thickness and steam passed through the upper and lower plates of the press, the heat will act on the vulcanizing substance and vulcanize the rubber while in position, thus firmly attaching each layer of the cloth to the next layer by means of the friction, which penetrates even into the fibers. This is

the basis of all hydraulic or duck packing and also of most of the rod packings. A strip may be cut off of this slab and be coiled up to form a roll of hydraulic packing. It is usually made of fine duck or a drill and has a white friction. If the duck be coarser and the friction black, the product is duck packing, or if sheets of rubber be placed on the top and bottom of the slab, the strip cut off may be wound into spiral form, and after being graphited, will make a spiral piston-rod packing. Since these strips are cut on the bias they are flexible and easily wound around a rod, plunger or piston.

Early expansion packing was made in this way, and as rubber expands under the influence of heat, it can readily be seen that when the stuffing-box becomes warm, the rubber of the packing will expand and press gently against the rod. Herein lies the "expansion" of the packing. Furthermore, the cut edges of the packing tend to absorb and hold the moisture of the condensed steam.

This packing, therefore, depends on two principles for performing its work. One is the expansion of the rubber in the cover and in the plies between the duck, and the other is the presence of the cut ends of the threads next to the rod. These cut ends absorb moisture which acts as a sort of "tangle-foot" to the steam as it tries to pass by.

This form of packing was soon improved upon by placing a rubber cushion back of the packing and next to the wall of the stuffing-box. When placed in this way the cushion would expand under the influence of heat and press the entire packing against the rod, and moreover, the cushion was not in contact with the high temperature of the rod.

A still further improvement lay in running some plies of duck through the rubber cushion, thus strengthening it against the back and forth rubbing action of the rod. But in this form expansion packing reached its highest development and is represented by the best brands of to-day. Packing of this class will leak for the first 10 or 15 minutes after the engine is started in the morning, or until the stuffing-box becomes thoroughly warmed. This warmth will expand the rubber, causing it to press against the rod and stop the leak.

In the use of this packing there are certain points to be particularly guarded against, the chief point being the strong probability of burning out the packing if handled by an incompetent engineer. Rubber has nothing to fear from pressure, but it has a great deal to fear from temperature. If a monkey-wrench is used, the packing will be compressed when cold and upon warming up and expanding will press against the rod with more than necessary force. As the pressure cannot be relieved in any way, it will produce an intense friction on the rod which will develop more heat and, increase the temperature until the packing loses its "life" or is actually carbonized. Here is where any engineer can ruin the packing by "monkeying" with the wrench on the gland nuts.

An expansion packing differs from the earlier form of packing in that it requires no pressure from the gland. The gland should only set up snugly against the packing to prevent it from working out. It was devised with the idea of producing a packing which would not require the attention of the engineer and therefore not be subject to abuse at the hands of ignorant men who persist upon the slightest excuse in using a monkey-wrench on the stub-bolts of the gland. Expansion packing, after once being properly set, needs no attention for many months, bearing in mind the fact that when cold it will always leak a little until it becomes warmed.

## The Quality of Steam.

By W. D. Spooner

In making a boiler trial it is important to determine as closely as possible the quality of the steam generated and ascertain whether it be wet, dry, or superheated. Many boilers, especially when generating steam rapidly, furnish wet steam, the water being carried over in the form of spray or even in drops. This water is not evaporated, and if not taken into account, will show for the boiler a higher efficiency than it really possesses. Hence the expression the "quality of steam" means the percentage of the water fed into the boiler which is evaporated into pure, dry steam. For example, if 100 pounds of water are fed into a boiler 96 pounds are evaporated into dry steam and 4 pounds are carried over in the form of water, the quality of steam is 9.6 per cent., the percentage of moisture being 4.

### The Throttling Calorimeter

In any case it is a rather difficult matter to make an exact determination of the moisture contained in steam. A calorimeter of the throttling type, used extensively for this purpose, is shown in Fig. 1. Steam is taken from the main steam pipe through a ½-inch connection usually provided with a valve, and from the ½-inch pipe passes through the two ¾-inch tees placed on opposite sides of the flange union, shown in Fig. 1. A thermometer well is screwed into each tee, and a piece of sheet iron, perforated in the center with a ⅛-inch hole, is inserted between the flanges. The joint is made tight with asbestos gaskets, which also act as non-conductors of heat. The thermometer wells are filled with mercury or heavy cylinder-oil, and the entire instrument from the main steam pipe to the 1¼-inch pipe, is well covered with hair-felt, an exceptionally good non-conductor of heat.

If the calorimeter is used often, great care must be taken that the ⅛-inch orifice does not become choked with dirt or sediment, and it is well to examine it at frequent intervals to make sure that it is in perfect condition. When the calorimeter is placed in service, the ½-inch valve is opened wide and steam is allowed to flow through it for 10 or 15 minutes in order to thoroughly warm it up before the actual test is made. Place a thermometer in each well and take readings from each at intervals of one minute, noting at the same time the pressure shown by the steam gage on the boiler.

### Principle of Action

In use the throttling calorimeter depends on the principle that dry steam when expanded from a higher to a lower pressure without doing external work becomes superheated, the amount of superheat depending on the difference in the two pressures. If there should be moisture in the steam, this moisture must necessarily be evaporated and the superheating will be proportionately less, the limit of the calorimeter being reached when the moisture present is sufficient to entirely prevent superheating. Assuming there is no back pressure in the 1¼-inch pipe and there is no loss of heat while the steam is passing through the instrument, the total heat in the mixture of steam and moisture before throttling and in the superheated steam after throttling will be the same.

Theoretically the boiler pressure is indicated by the temperature shown at the upper thermometer, but owing to radiation it is usually too low. It is better to use the reading of the boiler gage, if correct, or better still, to have a small test gage connected to the ½-inch pipe supplying steam to the calorimeter.

### Connection to Steam Main Important

Taking a sample of steam from the main steam pipe is a feature of the greatest importance. More erroneous results are due to improper connection than to any other cause. In making the connection with the steam pipe to attach the calorimeter, tap the hole for the ½-inch pipe as close to the boiler as possible, and always between the stop-valve and the boiler. The sample should be taken, if possible, from a vertical pipe, and only a plain, open-ended nipple projecting to about the center of the main steam pipe should be used. This arrangement avoids the collection of condensation that may be on the sides of the large pipe. Make all connections between the steam pipe and the calorimeter as short as possible, and avoid all pockets in which condensation can collect and run into the calorimeter.

As previously mentioned, there is a limit to the range of the throttling calorimeter.

When this limit is reached a small separator may be connected between the main steam pipe and the calorimeter, which will take out the excess moisture. By weighing the drip from the separator, and ascertaining the percentage of steam flowing through, the total moisture will be this percentage of moisture added to the moisture shown by the calorimeter. It is seldom, however, with a well designed boiler that the range of the calorimeter is not

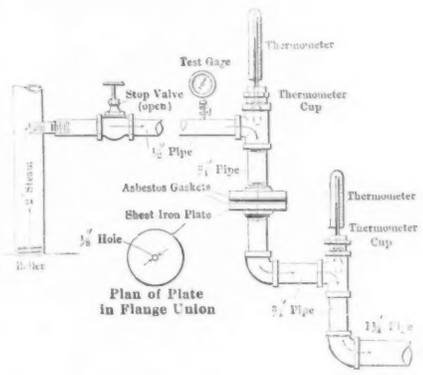



FIG. 1. CONNECTING THROTTLING CALORIMETER TO MAIN STEAM PIPE

sufficient, and it is only an extreme case where a separator has to be intervened between the steam main and the calorimeter.

### Determining the Quality of Steam

To illustrate the principle of operation in the throttling calorimeter, suppose the boiler pressure to be 85 pounds gage, 100 pounds absolute. If steam at this pressure is allowed to expand to the pressure of the atmosphere, there will be a certain amount of superheating, depending on the difference in the two pressures. The temperature of steam at 100 pounds absolute is 327.625 degrees, and steam at atmospheric pressure has a temperature of 212 degrees. Thus, the difference in temperature is

$$327.625 - 212 = 115.625$$

degrees if the pressure is taken as a basis, but steam that has been expanded to atmospheric pressure really contains more heat than this accounts for, and this is due to the low specific heat of steam. To determine the temperature of the steam due to the superheating, divide the difference in the two temperatures corresponding to the given pressures by the specific heat of steam, superheated, which is 0.4805. Hence

$$\frac{115.625}{0.4805} = 240$$

degrees, and

$$240 + 212 = 452$$

degrees, which should be the temperature of the superheated steam, or of the steam that has been expanded from 100 pounds absolute to atmospheric pressure without doing external work.

### The Barrel Calorimeter

There are many more or less complicated calorimeters in use, but the simplest and most available type for general use is the so-called barrel calorimeter shown in Fig. 2. A barrel or tank filled with water may be placed on a platform scale and weighed. The temperature of the water is registered by a thermometer inserted in the side of the barrel or tank. Steam is led into the barrel from the boiler through a pipe or piece of rubber hose, as shown in Fig. 2. It is well to have the tube bent and the end pointing up toward the surface of the water and placed as nearly in the center of the barrel as possible. This allows the steam to thoroughly mingle with the water, and the heat is more evenly distributed.

When using a barrel calorimeter to test the quality of steam, it is necessary to exercise great care, or errors will creep in sufficient to spoil the entire test. The best method to follow is to first make a note of the exact weight of the cold water in the barrel. Next, turn on the steam until the temperature of the water reaches 150 degrees, when the steam is shut off. This should be repeated two or three times in order to thoroughly warm up the barrel before making the actual test. The thermometer should be graduated to tenths of a degree, as the most important observation is the temperature. After the water has been heated for the actual test, the steam is shut off and the barrel and contents are again weighed. The difference between the weight and the original weight is the weight of the steam from the boiler. The average steam pressure on the boiler must be taken throughout the test. The weight of cold water and the rise in temperature are now known and also the weight of the steam or the mixed steam and water from the boiler. From any reliable table on the properties of saturated steam, the temperature of the steam can also be found, as the pressure is known.

If dry steam comes through the bent tube discharging into the water, its condensation should raise the temperature of the water in the barrel a certain amount. If the temperature is not raised this amount, a certain amount of water must have been carried over with the steam. In rare cases the temperature of the water might rise more than it would with dry steam, indicating that the steam coming from the boiler is superheated. A general rule to obtain the quality of the steam is given in the following:

Multiply the rise in temperature of the cold water by the weight of cold water and divide this product by the weight of the mixture led in through the tube. Subtract the final temperature of the water from the temperature of the steam and subtract the remainder from the quotient, number obtained. Divide the final remainder by the latent heat of a pound of steam at the average pressure throughout the test, and the result will be the quality of the steam. This rule is expressed by the following formula:

$$Q = \frac{1}{L}\left(\frac{W}{w}(t_2 - t_1) - t - t_2\right);$$

where

$W$ = Weight of cold water in barrel,
$w$ = Weight of mixture run into barrel,
$t$ = Temperature of the steam corresponding to the average pressure,
$t_1$ = Original temperature of the water,
$t_2$ = Final temperature of water,
$L$ = Latent heat of a pound of steam at the observed pressure,
$Q$ = Quality of steam.

For example, suppose the barrel in Fig. 2 to contain 418 pounds of water before starting the test. Let the temperature of the water equal 42 degrees. After the test has been made the temperature of the water, as shown by the thermometer, is 132 degrees. Weighing the barrel and contents, it is found that 36 pounds of steam has been condensed. The average pressure throughout the test was 65 pounds gage, 80 pounds absolute. Steam at this pressure has a temperature of 311.866 degrees, and the latent heat of steam at this pressure is 895.108 B.t.u. With these data the quality of the steam can be found by substituting values for the letters in the formula:

$$\frac{1}{895.108}\left(\frac{418}{36}(132 - 42) - (311.866 - 132) = 0.9665\right)$$

The quality of the steam is thus 96.65 per cent., that is, the boiler generates a mixture which is composed of 96.65 per cent. dry steam and 3.35 per cent. water.

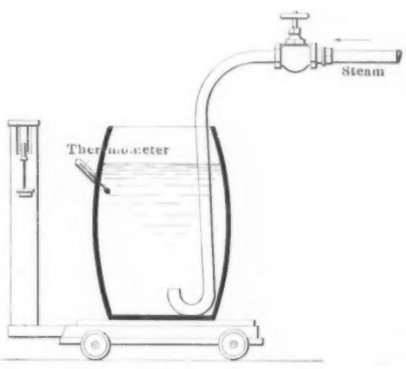



FIG. 2. BARREL CALORIMETER

For many years the standard apparatus for ascertaining the quality of steam was the barrel calorimeter, but this has of late years been superseded by some form of throttling calorimeter, which, when properly handled and connected, gives results far more accurate than can be obtained in any other way. The chief merit of the barrel calorimeter is its availability, for it can be fitted up in almost any situation.

# The Engineer a Gentleman

By J. C. Thorpe

To those who have gone aside a little from the course of regular engineering business to consider the engineer in his relation to men and things about him, some little misgiving has been experienced, when attention has been directed to the methods of lax morality and careless professional life that are too often smiled upon by men of the profession.

It has long been the opinion of the writer that the ethical side of engineering has received too little attention. In the close confinement to business affairs, and in the strenuous struggle for industrial supremacy, character building has been greatly neglected by many of those of influence in the engineering profession. It is not with the thought that anything particularly new will be presented here, but rather that a few points which all have considered more or less from time to time, may be again brought to attention and emphasized.

## Who and What is the Engineer?

Before considering the engineer, let us note something of the history of engineering, or better, perhaps, some of the steps in its development; and that we may approach on common and well understood ground, let us decide just who and what an engineer is. As a brief definition and a comprehensive one, I like to think of Tregold's definition: "An engineer is one who directs the great sources of power in nature for the use and convenience of man." Surely no better and no more inspiring field is given for men's work. And yet it is only within recent years that the engineer has lived on the same plane with the lawyer or teacher; it has not been a great many years that the followers of engineering have breathed the same air with the clergymen. But have the lawyer, teacher or minister a more gloriously fruitful field of labor? I think not.

Most of us have been taught to think of engineering as a comparatively new profession; that its history has extended over but a limited number of years. And, these impressions are based on fact, inasfar as they relate to the recent phenomenal growth of the science. But let us look back. In our histories of the middle ages, much space was given up to the records of the pontiffs or bridge builders, and even in those early times were recorded the labors of the chief engineer of maintenance of way, as the records of the *pontifex maximus*, the chief bridge builder, bear witness. This labor of bridge building was of such importance that it was considered essentially the field for men of learning, and we find the priests leading in this work as in teaching, preaching and ministering. It was necessary that these labors of such great public interest should be intrusted to men of scholarly and gentlemanly attainments. And, yet, since that early day, when problems of infinitely greater complexity have arisen, it has been thought that scholarship, temperance and integrity are not essential to the successful engineer. On the contrary, lax morals, intemperance and flexibility of conscience have been passed over without serious comment, if not, indeed, smiled upon.

It is interesting to note that a prosperous engineering society flourished during the early days of the Roman Empire when the *"Fratres Pontifici,"* Brotherhood of Bridge Builders, was organized by a band of monks who chose as their particular work the building and repairing of bridges. Many an old bridge and ancient cathedral stand today as the witness to the thoroughness and efficiency with which these and other engineers of their time did their work. In the process of time the extent of the work increased so rapidly that specialization became necessary and the monks, the men of letters to whom the world had looked as the chief lords of knowledge, withdrew to their sacred works of love and mercy and others appeared to build the bridges and buildings, and attend to the arts of the times. The engineer became merely an artisan with little if any book learning, depending upon precedent and physical strength to accomplish his designs.

## Importance of Hearty and Sincere Co-operation

The organization of these Benedictine monks emphasized an essential factor in successful engineering work which ought not to be passed over without comment. This brotherhood of engineers appreciated the all-importance of hearty and sincere coöperation for the successful termination of any great industrial work. It should be the aim of every engineer and of every engineering student to foster and encourage the spirit of constant striving for the best good of all—the spirit which constantly seeks the better things of life. Standards of right living should be upheld that shall make every engineer of the greatest possible good to the world of men and things about him. He should see beyond his own sphere of activities and come into close touch with those who have preceded him, as well as with those of his own time. It is only with this point of view that the least injury shall happen and the greatest benefit result to all.

The essential deep sympathy and wide outlook will come only as broad knowledge is gained. The engineer must not be learned in his profession only, but in history, political science, etc., as well. He must know everything about his own, and something about everything. For, as the engineer stands before the world as the equal in rank of the philosophers, lawyers, doctors and preachers, will he not be looked to for an example of right living as a citizen and as a man? I believe that the right is not his to seclude himself from society, politics and affairs of general importance, saying that the engineer must always be the serious, self-centered, preoccupied individual that some tell us he must be. A lofty conception of universal brotherhood and happiness should keep him from being hedged about in this manner. The realm of the engineer's work is such as to inspire him to strive at all times to add his might, however small it may be, to the store of happiness of the whole world.

## There is Need of the "Big" Man

Success and power in the life of an engineer, as in any life, are indications of energy, truthfulness, temperance, manly courage, self-respect and address. The engineer must be a man, true and strong. He must be not only scientific, scholarly and business-like, but healthy, erect and pure minded, possessing "manner" as well as manners. In no profession is there greater need for the truly "big" man.

An engineering feat once undertaken must be prosecuted with unceasing vigor and enthusiasm until the end is attained. The tunnels under the river in Greater New York were not built by dilatory methods, nor was the harness of our great Niagara Falls designed and constructed by indifferent engineers. If success is to crown his efforts, the engineer must keep "everlastingly at it" until he attains, for there is no greater need in any profession than this for "stick-to-it-iveness." This characteristic energy should be exhibited, not only in his work, but in his play as well. Other things being equal, that engineer will be the most successful who works while he works and plays while he plays, with all the vim and energy that a healthy mind and body can put forth.

No proverb is more golden, though perhaps none is more reviled in the broad field of engineering than the one we have all known all our lives: "Honesty is the best policy." There is no one thing that will make for ultimate happiness and success so surely as unswerving devotion to the principles of truth and honesty. And, on the other hand, there is nothing that will so surely bring ruin to one's self and work as disregard of these principles. The engineer must be true to himself, his work and to the world. If he is false to himself, nothing is surer than the ruin of his work with its author. Great mistakes have been made in medicine, law, theology, etc., and false theories advanced that have stood for years, yes, hundreds of years, without their falsity being proved, but a similar condition is not to be imagined in engineering. Would the great bridges that have been built and which stand as living witnesses of the engineer's proficiency, have withstood the tests of time if constructed on a false theory of the strength of materials or

design? Certainly not, and so be sure that false engineers cannot endure.

### Personal Honor

The consideration of honesty as an essential part of an engineer's life should not be left without a plea for that gentlemanly attribute, personal honor, that is being too little cultivated in this day when men are striving so fiercely for wealth and commercial supremacy. Such a quality of character must become a part of every true engineer. It should keep him above the advancements of those who are ever ready to offer inducements for professional influence. It should and will do away with the farce of so-called "expert testimony," when two engineers of similar training take opposite sides in a case in court, swearing to different effects from the same causes, the effect being influenced largely by the size of the interested party's pocketbook. Surely if the engineer is to maintain his position in the world where he has been placed by the great development of Nature's forces, he must cultivate this princely attribute. It is only thus that he may expect to deserve, secure and hold the confidence of those who are looking to him from time to time to "do things."

### The "Good Mixer"

The frequent records of discipline in the large industrial corporations of our country afford abundant evidence of the attitude against intemperance in the ranks of the employed. This hostility toward intemperate habits shows a very encouraging development along the line of all industrial pursuits and should serve as a warning, especially to young engineers. The old theory that a "good mixer" is necessarily more or less intemperate, is rapidly losing ground. The history of railroad management and operation is particularly noteworthy in reference to this subject. Can anyone imagine that the president or general manager of any of our great trunk lines would demand, as an essential requirement of service, that the prospective employee give evidence of a tendency to dissipate? In modern progressive industry, the intemperate man has no show with the alert, clear-eyed, moral fellow with a healthy and vigorous mind. Though men are to be found occasionally, not strictly temperate, who are in commanding positions, they invariably require temperance in their employees. The "good mixer" of the present is and for the future shall be, the well rounded man of ability, good address, and congenial temperament, but withal, of temperate habits in all points of life.

In the preface of one of our prominent engineering books the following paragraph appears: "A good engineer must be of inflexible integrity, sober, reliable, accurate, resolute, discreet, of cool and sound judgment, must have command of his temper, must have courage to resist and repeal attempts at intimidation; a firmness that is proof against solicitation, flattery or improper bias of any sort; must take an interest in his work; must be energetic, quick to decide, prompt to act and must be fair and impartial as a judge on a bench." These wholesome thoughts give more in detail those that have been discussed herein. These are the indications of high honor and gentlemanliness.

Living in the sphere of action in such close touch with Nature's forces, the whole trend of the engineer's life should be influenced. Every day should make him a better and a "bigger" man. If this is not true and his conduct is guided by a narrowed outlook and a shallow sympathy. If he is influenced by lax moral codes of living, he stands before the world a failure; he is not the engineer in truth, for he is not in touch with nature's great forces, and has not reached out to the wide fields of human service for which he was intended.

## Relation Between Real and Apparent Power in Alternating Current Circuits

By N. A. Carle

The terms "kilowatts" and "kilovolt-amperes" used in alternating-current calculations are somewhat confusing to a beginner, and the difference between them is not definitely understood. This article is intended to explain the meaning of these terms and to present graphically the arithmetic difference between them.

In direct-current calculations the product of the volts and amperes in the circuit gives the number of watts, and dividing by 1000 reduces this to kilowatts. This is expressed by the formulas

$$Watts = amperes \times volts$$

and

$$Kilowatts = \frac{amperes \times volts}{1000}.$$

In alternating-current calculations, in order to determine the number of kilowatts, or the true power, consideration must be given to the "power factor," whether the system is one-, two- or three-phase. This is expressed by the formulas

$$Watts = \frac{amperes \times volts \times power\ factor}{K}$$

and

$$K.W. = \frac{amperes \times volts \times power\ factor}{1000 \times K}$$

in which $K$ is the constant for the system used; in single-phase circuits, $K = 1$; in two-phase circuits, $K = 0.5$ and in three-phase systems $K = 0.58$.

The product of volts and amperes alone in an alternating-current circuit is called "kilovolt-amperes" and is expressed by the formula,

$$Kilovolt\text{-}amperes = \frac{volts \times amperes}{1000}.$$

The calculation of kilowatts in alternating-current circuits can be made rapidly by means of the charts on pages 352 and 353.

### Example

How many kilowatts are being delivered by a three-phase three-wire circuit, with 30 amperes in each wire and 2200 volts between wires, the power factor being 85 per cent.?

Using the chart on page 352, start with 30 "Current in Amperes," thence read up to 2200 "Voltage between Mains," thence across to 85 per cent. "Power Factor," thence down to three-phase "System" and across to approximately 98 "Kilowatts."

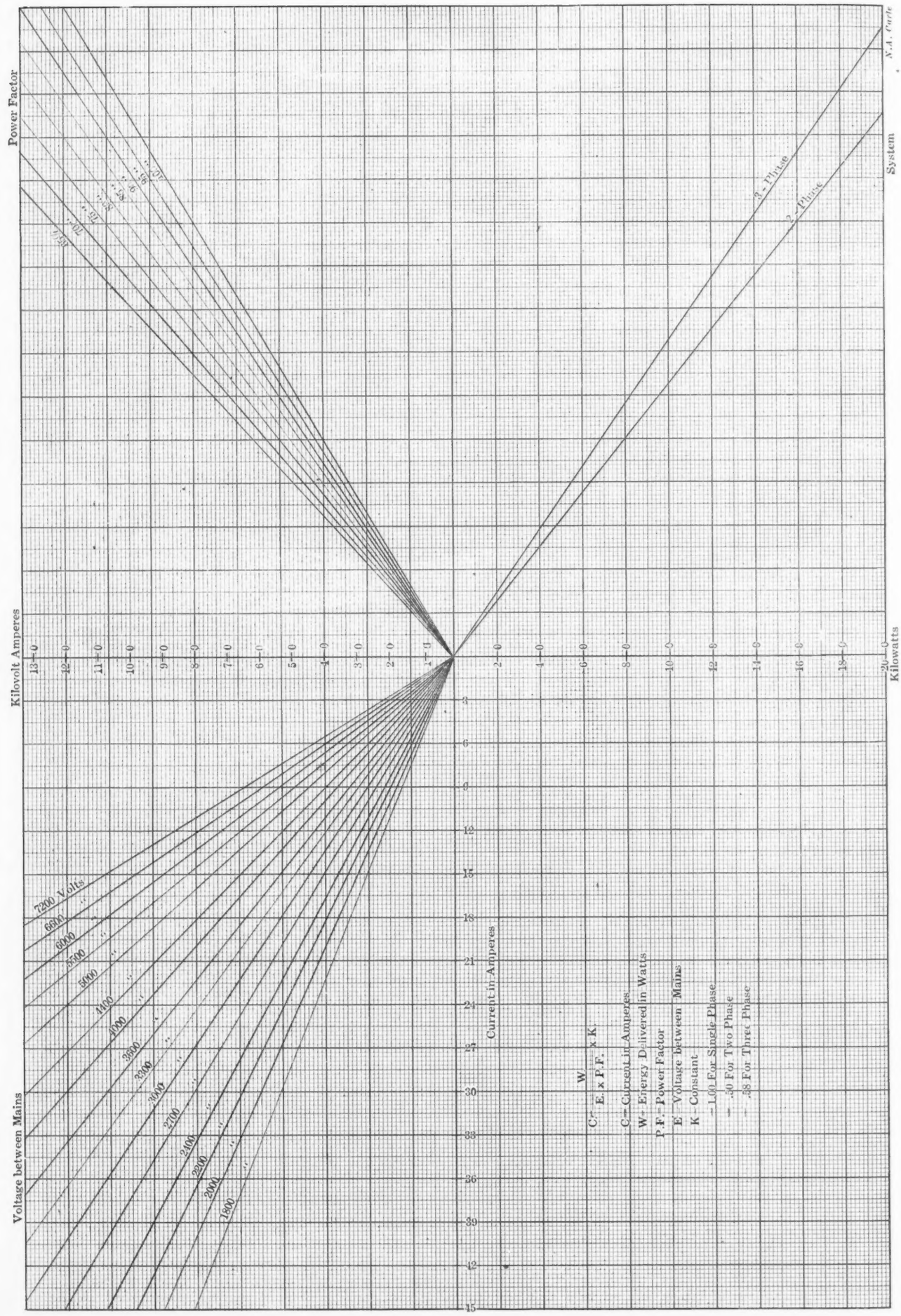
### Example

How many kilowatts are being delivered by a two-phase four-wire circuit, with 120 amperes in each wire and 400 volts between wires, the power factor being 95 per cent.?

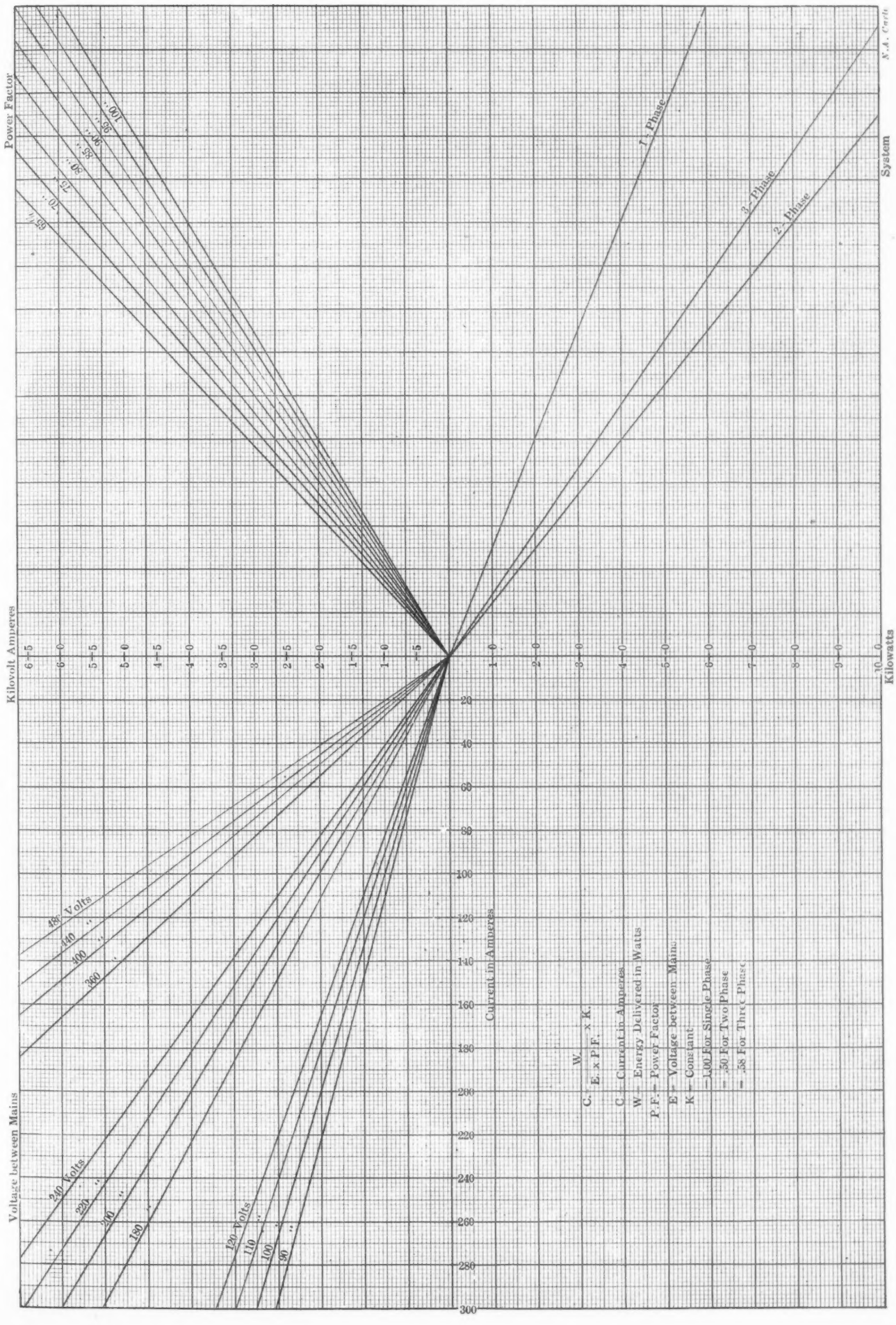
Using the chart on page 353, start with 120 "Current in Amperes," thence read up to 400 "Voltage between Mains," thence across to 95 per cent. "Power Factor," thence down to two-phase "System" and across to approximately 91.5 "Kilowatts."

The relation between "kilowatts" and "kilovolt-amperes" is readily seen by comparing the scales marked "Kilovolt-Amperes" and "Kilowatts." For direct-current calculations, the power factor is one and the system single-phase. Starting with any value of "Kilovolt-Amperes" and reading across to 100 per cent. "Power Factor," thence down to single-phase "System" and across to "Kilowatts," the value is the same as that started with.

For alternating-current calculations, if the power factor should be 100 per cent. and the system single-phase, then the kilovolt-amperes will be equal to kilowatts. If the system is single-phase, then the relation between kilovolt-amperes and kilowatts is the direct ratio of the power factor, and the kilowatts will always be less than the kilovolt-amperes. If the system is two- or three-phase, the relation between the kilovolt-amperes and the kilowatts will be a combination ratio of two factors. For a two-phase system, the kilovolt-amperes will equal the kilowatts if the power factor is 50 per cent., and will be less than the kilowatts if the power factor is more than 50 per cent. For a three-phase system, the kilovolt-amperes will equal the kilowatts if the power factor is 58 per cent., and will be less than the kilowatts if the power factor is more than 58 per cent. The power factor for both two-phase and three-phase systems is usually more than 60 per cent., so that for all ordinary calculations the kilowatts will exceed the kilovolt-amperes. In figuring kilovolt-amperes it must be remembered that the amperes are taken for one wire only—not the sum of the currents in all the wires.




RELATION BETWEEN REAL AND APPARENT POWER IN ALTERNATING-CURRENT CIRCUITS




RELATION BETWEEN REAL AND APPARENT POWER IN ALTERNATING-CURRENT CIRCUITS

# Combined Power and Hot Water Heating Plant*

## General Management of the Special Apparatus Required, Preceded by a Description of the Arrangement and Operation of the Plant

BY CHARLES L. HUBBARD

### Steam Piping

In Fig. 1, on page 302 of the August 25 number the general arrangement of the steam and exhaust piping was shown, and details of the boiler connections in Figs. 5 and 6. The leads from the boilers connect with a common header which separates into two branches, one leading to the pump and blower engines and the other to the lighting engines. Pipes are also carried to the stokers and to the laundry, which is located over the boiler room. The main leading to the engine room is provided with a large separator made up of pipe and standard fittings, as

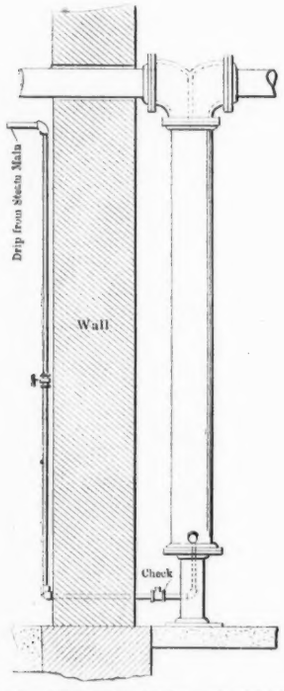



FIG. 13. SIDE ELEVATION OF SEPARATOR

shown in Fig. 13. At the top the tee has a baffle-plate cast across the inside, which deflects the steam downward as it enters, and so separates a portion of the entrained water. The separator is dripped through a high-pressure trap to the main receiver.

Exhaust from the various engines is discharged into an 8-inch main in the engine room and passed through an oil separator of special design. This is shown in detail in Fig. 14, and consists of a large shell or cylinder of wrought iron having a horizontal division or filter about 12 inches in thickness, the filter being made up of excelsior held in place between two coarse wire gratings. The exhaust enters at one end below the filter and passes upward through it, while the oil is caught by the excelsior and drains back to the bottom of the chamber, from where it is dripped to the sewer through a siphon trap of large size. From the oil separator the exhaust steam passes to the heater in the engine room. Branches are carried to the feed-water heater and also outboard through a back-pressure valve. A cross-connection containing a pressure-reducing valve, is made between the steam and exhaust lines near the first centrifugal pump, for maintaining the pressure in the heater when the exhaust is not sufficient.

### Feed Apparatus

This consists of a large rectangular receiving tank made of boiler iron, two steam pumps and a vertical feed-water heater of the closed type. The tank receives the drips from the traps, the most important being that from the large exhaust heater. A constant water level is maintained by means of a ball-cock connection with the city mains. The pumps are duplicates, each capable of doing the entire work alone, and one is run continuously at a speed sufficient to supply all of the boilers in use. The quantity of water supplied to the boilers is regulated by means of throttle valves in the feed connections, and any surplus which is pumped into the feed main is discharged back into the receiving tank through a relief valve, as shown in Fig. 15. The feed-water heater has a single steam connection at the top the same as the large exhaust heater.

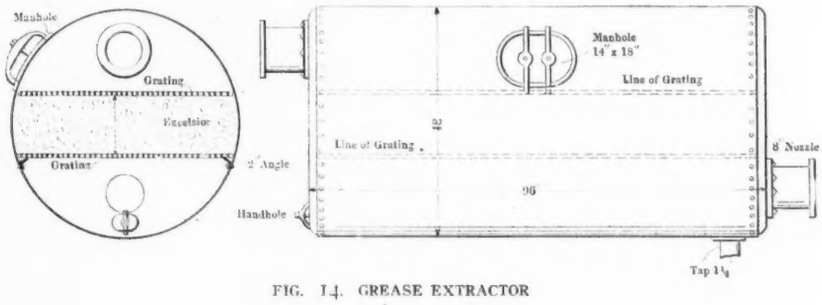



FIG. 14. GREASE EXTRACTOR

### Blow-off Connections

All four of the boilers are drained through a blow-off tank made of boiler iron, mounted on supporting cradles and located at the rear of the boiler room. The method of making the connections is shown in Fig. 16. Ordinarily the tank stands full of water. The hot water from the boiler enters at the top of the tank, and forces the cool water out from the bottom through the extended overflow pipe. A vapor pipe is carried outboard from the top, and a small pipe is carried from this to the top of the discharge pipe to break the siphon and prevent the tank from being drained each time a boiler is blown off.

### Details of Design

Having shown the general arrangement of the various pieces of apparatus in a combined power and heating plant of this kind, it may be of interest to take up briefly the method of proportioning some of the more important parts of the heating plant, such as boilers, heaters, pumps, size of main, etc.

### Heating Boilers

In the design of a heating boiler the first step is to determine the heat units to be supplied to the radiation. This may be found by assuming efficiencies of 170 and 400 heat units for each square foot of surface per hour for direct and indirect hot-water radiation, respectively. That is, the number of square feet of direct radiation multiplied by 170, plus the square feet of indirect surface multiplied by 400, will give the total number of heat units to be supplied per hour by the boilers. If the building contains a hot-blast heater for ventilating purposes, it may be taken as equivalent to six times its surface counted as direct radiation. To cover the heat lost by radiation from the mains and risers, it is good practice to supply about 10 per cent. more heat than is given off by the radiating surface. The boiler horse-power is found by dividing the

*The first section of this article was published in the August 25 number.

total number of heat units to be supplied by 33,000.

In the case of a multi-tubular steam boiler it is customary to provide from 12 to 15 square feet of heating surface per horse-power, depending upon its size, the probable chimney draft and the care it is to receive. With a hot-water boiler under forced circulation, the heating surface becomes more efficient owing to the lower average temperature of the water and its more rapid rate of flow over the hot plates and tubes. For this reason it is safe to count on one horse-power from each 10 to 12 square feet of heating surface. The thickness of the shell plates depends more upon their rigidity and durability than upon the actual pressure which the boiler carries. The static pressure upon a water boiler is that due to the elevation of the expansion tank of the heating system. In the case of a modern office building this is an important factor, so that the pressure to be carried should always be considered as one of the conditions to be provided for The boilers shown in Fig. 2 are made of 7/16-inch plate and are operated under a static head of about 50 feet, or roughly, 25 pounds per square inch.

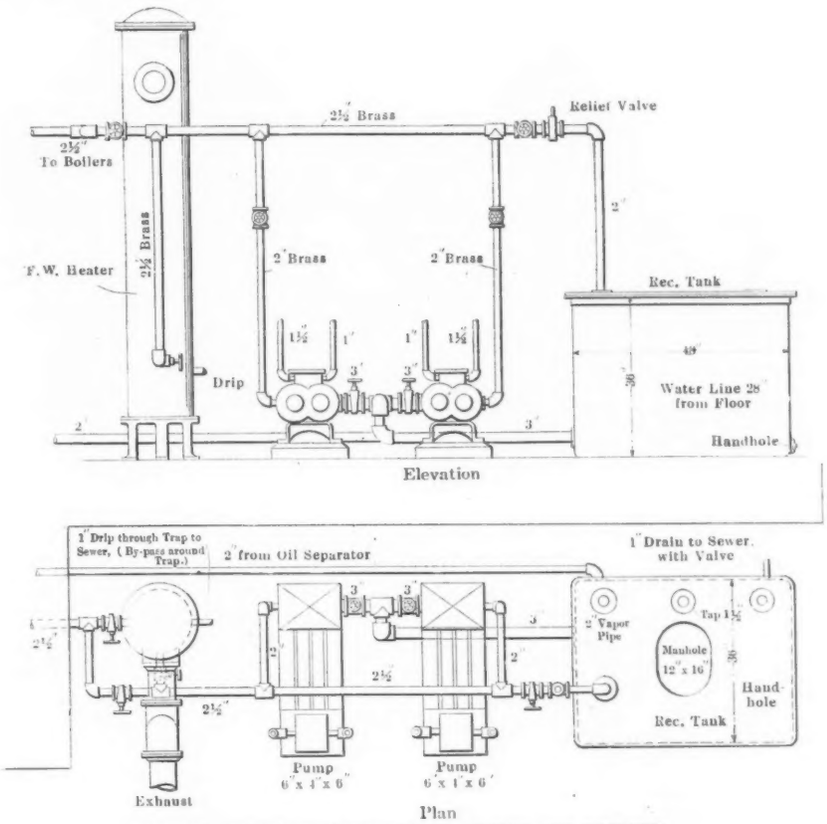



FIG. 15. PIPING CONNECTIONS TO PUMPS AND RECEIVER

### Steam Heaters

Steam heaters, as used in this plant, are practically the same as an ordinary feed-water heater of the closed type, except that the connections are reversed so that the steam is inside the tubes and the water outside. The efficiency depends upon the difference in temperature between the steam and the surrounding water, and also upon the velocity of the water through the heater. For average conditions with the type of heater commonly used for this purpose, it is customary to assume an efficiency of 200 heat units per square foot of heating surface per hour, per degree difference in temperature between the steam and the water.

Under average conditions it is usual to heat the water to about 180 degrees, and to allow for a drop in temperature of 30 to 40 degrees in passing through the heating system. Assuming the lower figure, an average temperature of

$$\frac{180 + 140}{2} = 160$$

degrees for the water passing through the heater, is obtained. The temperature of steam at atmospheric pressure is 212 degrees, which gives a difference of

$$212 - 160 = 52$$

degrees between the steam and the water. If each square foot of tube surface in the heater gives up 200 heat units per degree difference of temperature, then

$$200 \times 52 = 10{,}400$$

heat units will be transferred to the water by each square foot of surface per hour. Therefore, the total heat to be supplied, divided by 10,400, will give the square feet of tube surface to be provided. Assuming an efficiency of 170 heat units for direct radiation, 400 for indirect and 1020 for hot-blast coils, the following ratios are obtained: One square foot of tube surface in the heater will supply 61 square feet of direct, 26 of indirect, and 10 of hot-blast radiation.

Feed-water heaters are commonly rated on a basis of 1/3 of a square foot of surface per horse-power, so that it is an easy matter to compute the size of the heater required for any given case.

### Pumps

Pumps in size and speed depend upon the volume of water to be moved and the head against which they must operate. One gallon of water weighs approximately 8.3 pounds, and in cooling 40 degrees in temperature, will give out

$$40 \times 8.3 = 332$$

heat units. Therefore, the total number of heat units given off per minute by the radiation, divided by 332, will give the gallons of water to be moved by the pump in that length of time.

The head against which the pump must work is determined by the size and length

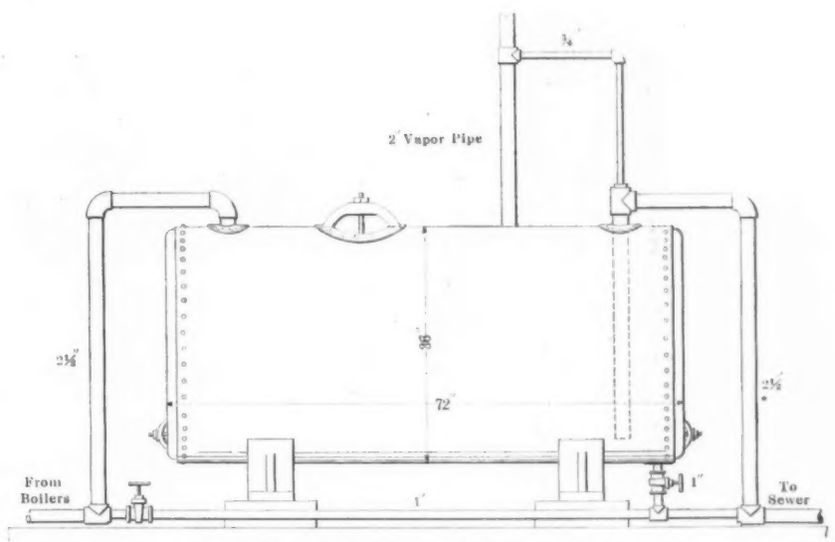



FIG. 16. CONNECTIONS OF BLOW-OFF TANK

of the main. As the water in the heating system is in equilibrium, the only opposing force to the action of the pump is that necessary to overcome the friction in the mains, and is called the "friction head." In practice the mains are commonly made of such size that the friction head averages between 30 and 50 feet in buildings of large size. In the ordinary form of centrifugal pump the efficiency falls off quite rapidly for heads much above 35 to 40 feet, although special high-speed pumps are constructed which operate satisfactorily against a pressure equivalent many times greater.

Fig. 17 shows a direct-connected outfit driven by a steam engine. This is a common form of hot-water pump, and is run at a comparatively low speed. An electric outfit is shown in Fig. 18. These are designed for a higher speed, and are made to operate against high pressures when desired.

In deciding upon the size of pump to use, it is usually best to submit the conditions under which the pump is to operate to the manufacturers and have them select a size which they will guarantee to do the work easily and economically. The catalogs of most makers of centrifugal pumps contain

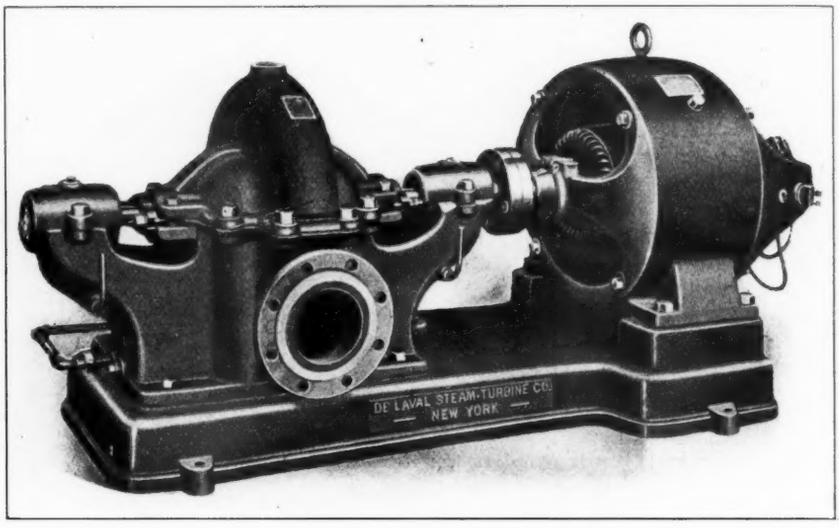



FIG. 18. MOTOR-DRIVEN HIGH-SPEED PUMP

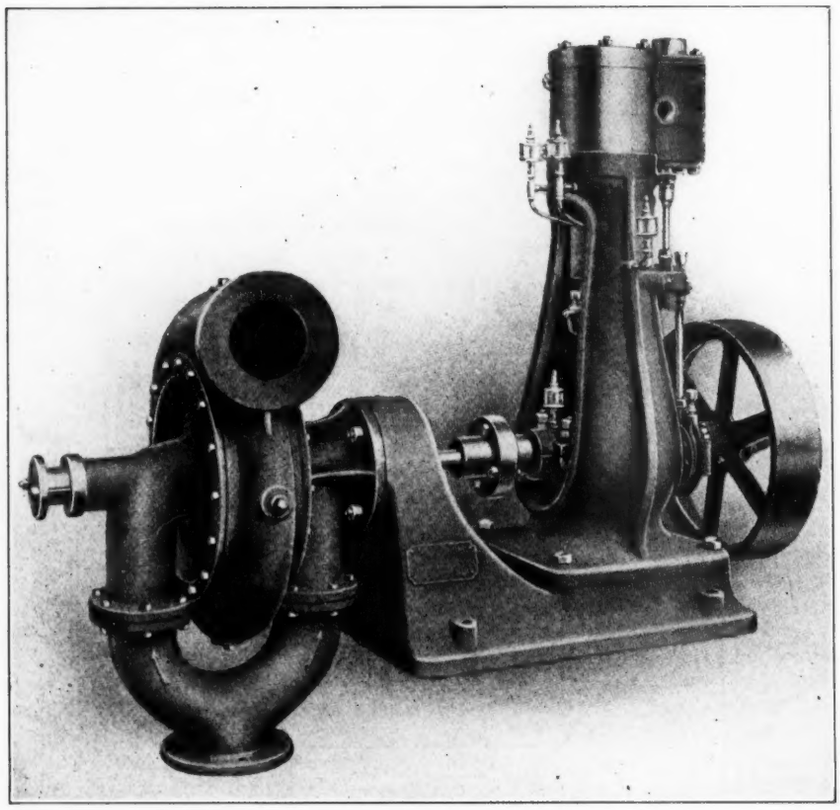


FIG. 17. LOW-SPEED HOT-WATER-PUMP

tables giving the most economical capacities in gallons per minute for pumps of different size, together with the necessary speed to produce different heads.

As given in the Lawrence catalog, the standard patterns are made for "high lifts at slow speed," including pressure heads from 16 to 90 feet; "medium lifts at medium speed," with heads from 6 to 60 feet; and "low lifts at high speeds," with heads from 4 to 40 feet. A 4-inch pump in the first class, in order to work against a 30-foot head, has an impeller 26 inches in diameter, and must run at a speed of 405 revolutions per minute.

The same size of pump in the second class has an impeller 14 inches in diameter, and in order to operate against the same head must run at a speed of 765 revolutions. In the third class the same size of pump has an impeller 10 inches in diameter, and must have a speed of 1050 revolutions to produce the same results.

It is thus evident that for any particular case the proper size of impeller will depend upon the method of driving the pump. For example, if it is desired to use a direct-connected steam engine at a low speed, an impeller of large size should be used, while in the case of a motor-driven pump a small impeller at a high speed would be selected to secure the same results.

For moving a given volume of water per minute the horse-power required is equal to the weight of water multiplied by the head against which it is moved, and the product divided by 33,000. In practice the power required to overcome the friction of the pump must be added. The efficiency of a centrifugal pump may run as high as 70 per cent. or more, but for this class of work it is more usual to take it at 50 per cent. Placing the horse-power rule in the form of an equation, we have:

$$H.P. = \frac{G \times 8.3 \times E}{33{,}000},$$

in which

$G$ = Gallons pumped per minute,
$E$ = Efficiency of pump = 0.5.

### Size of Mains

This depends upon their length and the volume of water which is to pass through them. In heating work it is customary to use mains of such size that the velocity of flow will not exceed about 10 feet per second for diameters of, say, 6 to 8 inches, while the velocity for smaller pipes should be reduced to about 5 feet for diameters of 2 or 3 inches. Table 1 gives the capacity in gallons per minute discharged at velocities in feet per second from 3 to 10, also the friction head in feet per 100 feet length of pipe.

In computing the length of main, the

TABLE. 1. CAPACITY IN GALLONS PER MINUTE DISCHARGED AT VELOCITIES IN FEET PER SECOND, FROM 3 TO 10. ALSO FRICTION HEAD IN FEET PER 100 FEET LENGTH OF PIPE.

| Diam. Pipe. | 2-inch. | | 2½-inch. | | 3-inch. | | 4-inch. | | 5-inch. | | 6-inch. | | 7-inch. | | 8-inch. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Velocity. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. | Capacity. | Friction. |
| 3 | 29.37 | 2.04 | 45.91 | 1.632 | 66.09 | 1.36 | 117.50 | 1.02 | 183.63 | 0.816 | 264.24 | 0.68 | 359.79 | 0.583 | 470.04 | 0.510 |
| 4 | 39.16 | 3.41 | 61.21 | 2.72 | 88.12 | 2.28 | 156.67 | 1.71 | 244.84 | 1.36 | 352.32 | 1.13 | 479.72 | 0.976 | 626.72 | 0.854 |
| 5 | 48.95 | 5.12 | 76.51 | 4.10 | 110.15 | 3.41 | 195.70 | 2.56 | 306.05 | 2.05 | 440.40 | 1.70 | 599.65 | 1.46 | 783.40 | 1.28 |
| 6 | 58.74 | 7.16 | 91.81 | 5.72 | 132.08 | 4.78 | 235.84 | 3.58 | 367.26 | 2.86 | 528.48 | 2.38 | 719.58 | 2.05 | 940.08 | 1.79 |
| 7 | 68.53 | 9.54 | 107.12 | 7.62 | 154.21 | 6.36 | 274.98 | 4.77 | 428.47 | 3.81 | 616.56 | 3.18 | 839.51 | 2.72 | 1096.70 | 2.38 |
| 8 | 78.32 | 12.2 | 122.42 | 9.80 | 176.24 | 8.16 | 314.12 | 6.12 | 489.68 | 4.90 | 705.64 | 4.08 | 959.44 | 3.49 | 1253.4 | 3.06 |
| 8½ | 83.23 | 13.7 | 130.15 | 10.98 | 187.25 | 9.15 | 333.75 | 6.86 | 520.61 | 5.49 | 749.01 | 4.57 | 1019.4 | 3.92 | 1331.5 | 3.43 |
| 9 | 88.11 | 15.2 | 137.72 | 12.22 | 198.27 | 10.1 | 352.26 | 7.64 | 550.89 | 6.11 | 793.72 | 5.09 | 1079.4 | 4.36 | 1410.1 | 3.82 |
| 9½ | 93.00 | 16.9 | 145.31 | 13.54 | 209.24 | 11.2 | 371.90 | 8.46 | 581.25 | 6.77 | 837.08 | 5.61 | 1139.4 | 4.83 | 1488.0 | 4.23 |
| 10 | 97.90 | 18.6 | 153.02 | 14.92 | 220.30 | 12.4 | 391.40 | 9.33 | 612.10 | 7.46 | 881.80 | 6.21 | 1199.5 | 5.33 | 1566.8 | 4.66 |

various bends and fittings must be taken into account, and their frictional resistance in an equivalent length of straight pipe must be added to the main. Table 2 gives the frictional resistance of various valves and fittings, and will be found useful in these computations. The use of Tables 1 and 2 are best illustrated by working a practical example.

A circuit main in a hot-water heating plant must have a capacity of 490 gallons per minute. The length is 600 feet, and there are 12 long-turn ells and four short-turn ells in the run. It is desired to keep the pressure head between 30 and 40 feet. What will be the required diameter?

First, assume a velocity of 8 feet per second; following along this line in Table 1, it will be found that a 5-inch pipe will discharge 489.68 gallons per minute at this velocity, which is satisfactory. The head required to discharge this quantity through 100 feet of pipe is 4.9 feet (see Table 1). The next step is to find what head will be required under the actual conditions. Here we have

| | Feet. |
|---|---|
| Length of pipe | 600 |
| Equivalent in long-turn ells = 4 × 12 | 48 |
| Equivalent in short turn ells = 9 × 4 | 36 |
| Total length of main | 684 |

Total head to be pumped against is

$$6.84 \times 4.9 = 33.5$$

feet, which comes between the limits required.

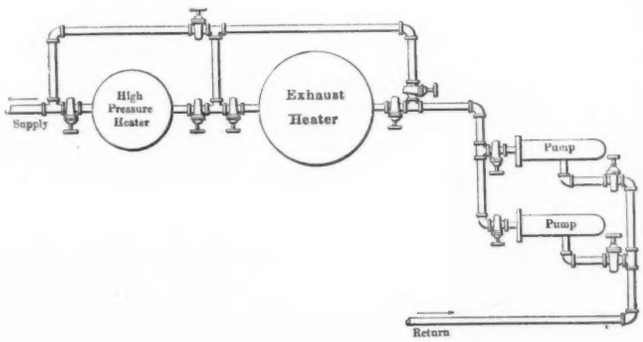



FIG. 19. HEATERS IN SERIES

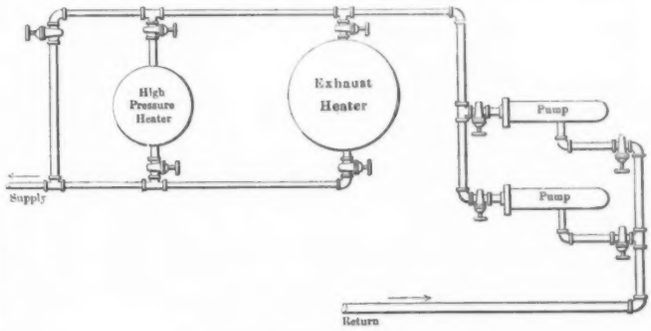



FIG. 20. HEATERS IN PARALLEL

### Arrangement of Piping

For making the piping connections between the pumps and heaters a general method has already been shown in Fig. 7. In a majority of cases a live-steam heater is used in place of the regular heating boilers for assisting the exhaust heater. Figs. 19 and 20 show the methods of making the connections in a case of this kind. The first is a special arrangement adopted by the Evans-Almirall Company, in which the heaters are placed in series, the water from the pumps first passing through the exhaust heater and then through the live-steam heater. In the second case the two heaters are placed in parallel and the flow through each is properly proportioned by means of throttle valves suitably adjusted. In both cases cut-out and bypass valves are provided for each pump and heater.

TABLE 2. FRICTIONAL RESISTANCE OF VARIOUS FITTINGS IN EQUIVALENT STRAIGHT PIPE LENGTHS.

| Name of Fitting. | Number of feet of clean, straight pipe of same size which would cause the same loss as Fitting. |
|---|---|
| 6-inch Pratt & Cady check-valve | 50 |
| 6-inch Walworth globe check-valve | 200 |
| 4-inch Pratt & Cady check-valve | 25 |
| 4-inch Walworth globe check-valve | 130 |
| 2½-inch to 8-inch long-turn ells | 4 |
| 2½-inch to 8-inch short-turn ells | 9 |
| 3-inch to 8-inch long-turn tees | 9 |
| 3-inch to 8-inch short-turn tees | 17 |
| ⅛ bend | 5 |

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The Hydro-Electric Commission, of Ontario, of which Hon. Adam Beck is the head, recently awarded a contract for the building of a 293-mile power-transmission line, to cost $1,270,000, which will extend from Niagara Falls to St. Thomas on the west and to Toronto on the east.

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The Denver, Northwestern and Pacific railroad is shortening the route between Denver and Salt Lake City some two hundred miles by a short cut, which opens up some six hundred square miles of coal land in the northwestern corner of Colorado. The coal is above the average grade of Colorado coal, much of it being semi-bituminous. They are putting in a pair of 28x60 first-motion Corliss engines with two large haulage drums built by Wellman, Seaver & Morgan, and a thousand horsepower of Lyons boilers.

## Electricity and Steam for Anthracite Mines

In the outskirts of Scranton, the Delaware, Lackawanna & Western Railroad Company has just completed a power plant, which is the greatest establishment of its kind in the anthracite region. It supplies steam to five collieries and electricity to fifteen collieries with a total daily output of 25,000 tons of coal. The nearest of these collieries is only a few hundred feet from the plant; the most distant is three miles away. Three hundred tons of coal are consumed under the voilers every twenty-four hours, and during a recent month 187,695,700 pounds of water was turned into steam. On a regular working day the boiler plant is run at a capacity of 10,000 horsepower.

The locality where the boiler and power houses stand is known as Keyser valley. Here and in the vicinity are the most productive of all the Lackawanna mines. There has been an installation of boilers and electrical-generating machinery there for some time, but the present enlargement has made practically a new plant of it. Advantage has been taken of the latest inventions to make the operation as efficient and economical as possible. After the improvements of the last year, the plant represents an investment of about half a million dollars.

Since many mines, employing thousands of mine workers, depend upon the steam and electricity from the Keyser-valley plant, it is absolutely necessary that no interruptions occur, for an interruption would render thousands of men idle. Hence all the equipment, even to the pumps and the big fans for the forced draft, are supplied in duplicate.

A water-supply system, capable of supplying a good-sized village, had to be provided to feed the boilers. The water is brought down from West mountain nearby, and flows into a reservoir that will hold 750,000 gallons. From the reservoir it goes into the boilers, but is first passed through a feed-water heater, is heated to a temperature of 208 degrees, and is then run through an economizer before entering the boilers.

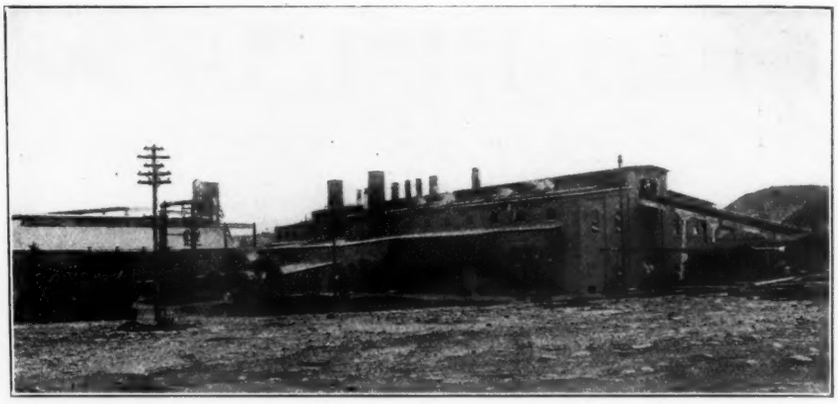

FIG. 1. THE POWER PLANT AT SCRANTON

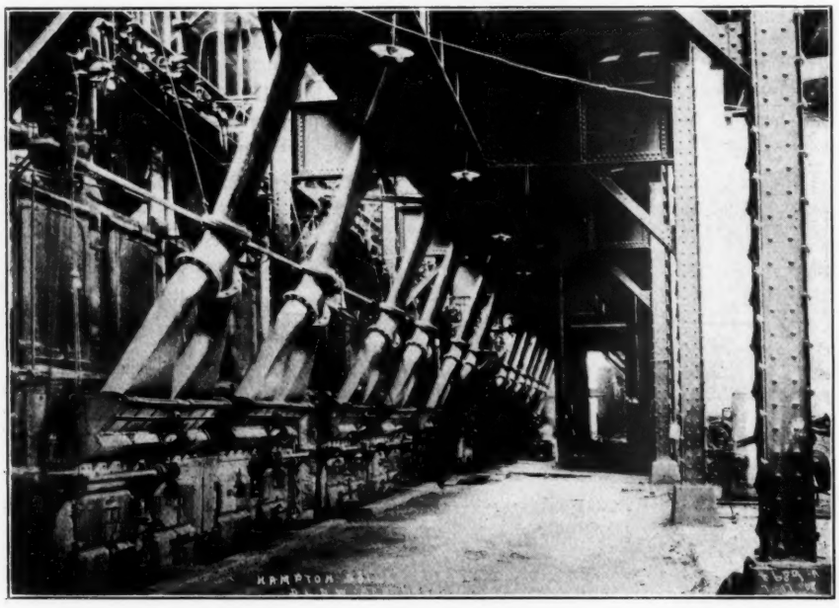

FIG. 2. A VIEW OF THE BOILER ROOM

### Feeding the Fires

Coal for the boilers comes from washeries nearby in ordinary railroad coal cars, from which it is dumped into a concrete pit. Just under an opening in this pit runs an endless rubber belt, depressed in the middle to form a trough into which the coal falls from the pit. The belt conveyer runs up a gradual incline and then along an upper floor in the boiler house, and is "tripped" off into a chute leading down to the bunkers from which the fires are fed. The belt handles 50 tons an hour. Another belt, parallel to the one now in operation, for loading another line of bunkers, will be installed soon. The bunkers have a capacity of 1000 tons.

### Ashes Flushed Into Mines

How little waste there is in the Keyser-valley plant is shown by the fact that even the ashes are put to use. They fall

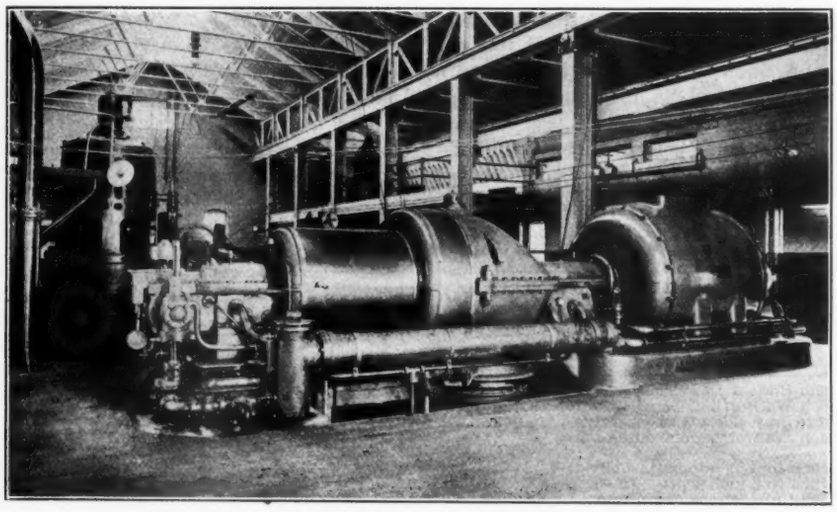

FIG. 3. THE TURBINE AND SWITCHBOARD GALLERY

from the ash pits into a tunnel which slopes at a grade of ⅜ inch to the foot. Water pumped from one of the nearby mines is brought into this tunnel and flushes the ashes into a borehole leading to another part of the mine. The ashes are carried, with the flow of water, to the abandoned workings. There they pile into a mass and become solid when the water drains off. In this way the ashes take the place of the coal already mined and form pillars to support the rock and earth above. When enough pillars of this kind have been formed the "robbing" may begin, that is, the good coal which had to be left, to prevent surface cave-ins, may be taken out and marketed. The use of the ashes is thus made a direct money saver. It is estimated that about 50 tons of ashes are flushed into the mines every day.

Besides supplying steam and electricity for the operation of the collieries, in winter the boilers put about 2000 horsepower into heat for the breakers.

### The Electric Installation

Like the boiler plant, the electrical end has been so improved that it is practically new. Along one side of the big room are five 500-kilowatt Curtis turbines, with direct-connected alternators. The turbines run at 1800 revolutions per minute and generate a current of 2300 volts. Running crosswise of the room, toward one end, is an Allis-Chalmers turbine, direct connected to a 2000-kilowatt Bullock generator. It also runs at 1800 revolutions a minute and generates a current of 2300 volts.

Four of the Curtis turbines are equipped with Worthington jet condensers and one is equipped with a Worthington surface condenser. The Allis-Chalmers turbine is equipped with a jet condenser of another type. The water for all these comes from the mines, reaching the power house through a 24-inch concrete pipe. The plant has two traveling cranes with a carrying capacity of 10 tons each.

The current is sent out through overhead wires. It lights the mines and breakers and runs all the electric locomotives in the neighboring mines. It also lights the passenger station in Scranton and the railroad shops there, this being the only respect in which the Keyser-valley plant is devoted to other work than the mining of coal.

In the old buildings there was considerable wood, but there is none about the new plant. Everything is of reinforced concrete, iron or steel. The oil house is concrete, as well as the wash house, where there are shower baths and lockers and tubs for the men. The incline for the rubber belt conveyer is supported by concrete columns. All the construction is absolutely fireproof.

## The Real Efficiency of Steam Boilers

By W. H. Booth

From time to time new inventions are brought to public notice, and their claims to the public attention are very properly and naturally supported by the reports of tests made by experts. These reports contain figures that will not always bear investigation. There are two main classes of expert, those who make an honest endeavor to put forward figures that are both rational and truthful, and those who set themselves deliberately to put forward figures which are not true. The latter figures are liable to get through without being found out, as it is not everybody's business to investigate the figures obtained from the results of tests.

As a result of examining a few reports on boiler tests, it appears to the writer that a different method of stating boiler efficiencies ought to be adopted. Certain published figures of boiler tests, together with the statement of the efficiency obtained, have shown that the figures given are not compatible with the efficiency claimed.

In a recent boiler test carried out by the writer, it was necessary to blow all the steam into the air, and, owing to the noise, which could not be prevented, the test was run somewhat below modern pressures. It was pointed out by a critic that owing to this the boiler would be so much cooler and the efficiency of its heat-absorbing surface would be so much better, that the test would appear better than a similar test at the full pressure at which it was intended the boiler should be worked. As a result of this criticism, it was resolved to publish the results in such a way that no fault could be found with the figures nor with the statement of efficiency.

### Usual Method of Computing Efficiency

In the first place, what is the efficiency of a steam boiler as usually stated? In expert tests it ranges from 70 to 87 per cent., and this figure stands for the percentage of the calorific capacity of the fuel, which is found in the steam produced by the boiler. The difference between the figure of efficiency and the full number of 100 has to include the heat which goes up the chimney and that which is lost by radiation from the boiler. It is customary only to debit the boiler with the coal actually consumed, crediting it with the weight of unburned fuel and of the ashes and clinkers. This is perfectly correct practice because it places all boilers much on an equality, no matter what the quality of the fuel, and no serious objection can be taken to the practice so long as the ashes are properly collected and weighed dry. If ashes do get wet, they should be dried thoroughly before weighing, for they hold a lot of water.

Now the waste up a chimney and the radiation are apt to make up quite a large proportion of the total calorific capacity of the fuel, and when these total losses are all included in the figure of 13 per cent., one feels inclined to examine the other or complementary figure of 87 per cent.

As far as the writer's knowledge goes, an efficiency as high as 87 per cent. has never been obtained from any commercial steam boiler, with the ordinary method of stating efficiencies. In tests conducted by myself, I have had the help of firemen as good and as efficient as can be obtained by any other testing engineer. I have had as accurate instruments, and I may have been more careful than are some of them in weighing the feed water, not simply calibrating the vessel and figuring on a 62½-pound per cubic foot basis; whereas, the feed being considerably hotter than 60 degrees, one cubic foot of it does not weigh 62½ pounds. It is therefore preferable, where practicable, to weigh each tank of water.

### A Safeguard Against Error

The most difficult thing in a boiler test is to keep count of each item of coal and each item of feed water. It may seem simple to do this, and the college professor, who has a staff of earnest students to help him, may consider he is fortunate, but an ordinary commercial test has to be done with a small staff and errors are apt to creep in. It is therefore desirable to plot a test on a sheet during its progress, setting a dot on a time line for each 100 pounds of coal and each 100 gallons of water. Any omission to register either will show an unbelievable jog in the plotted record, if care be taken to book each item at the moment the last item has been used up. The regime of a boiler is found to be so regular that the curves of performance are very nearly straight lines, and the method is therefore a great safeguard against error.

### Real Efficiency

It was our purpose, however, to show that customary methods of stating boiler efficiency are entirely wrong, because they do not take into account all the factors. So much coal is consumed in the furnace, and this coal has a certain calorific value. So much water is evaporated into steam, and this contains so much heat over and above the heat in the feed water. At one time it was quite usual to test all boilers at atmospheric pressure, the manhole cover being off and evaporation taking place at 212 degrees Fahrenheit. This practice would certainly place boilers much on an equal footing, but they would be still better equalized if the outflowing steam passed through a coil in the feed tank, so that the feed might be heated to 212 degrees Fahrenheit and the boiler

performance measured strictly from and at 212 degrees Fahrenheit. But, after all, this would not be commercial testing, for it is a sin to waste fuel on a test. The steam ought to be used. Nor does it fit with the conditions under which the heating surface has to do its work when the boiler is under pressure.

In the writer's practice it has been customary to rate the efficiency of a steam boiler upon the basis of the ratio of the heat in the steam it produces to the heat of the fuel presented to it, at or above its own temperature. No boiler can absorb heat from gases whose temperature is below that of the boiler. Ordinarily, a steam boiler is some 200 degrees colder than the chimney gases, or the gases which leave the last heating surface of the boiler. In some of the 87 per cent. efficiencies it was found that from the given temperature of the chimney gases and the minimum practicable allowance of air per pound of fuel, the ratio of the total heat lost up the chimney could not have been less than a certain figure. This heat added to the percentage of heat in the steam, as claimed in the test figures, made up a total heat greater than was in the fuel. That is to say, of the heat presented to the boiler above its own temperature, which is all that an ideal boiler can absorb, the boiler had somehow contrived to absorb 104 per cent. When the engineer put forward such figures, he was merely stating boiler efficiencies in the usual way and had become so accustomed to this way of doing it, that it probably did not occur to him to check his computations, and so reduce his tests to a better reckoning.

Had he followed the method of stating the real efficiency, he could not have unwittingly fallen into error, for in the newer way it is first necessary to know how much heat is actually offered to the boiler above its own temperature, and since we have to find this by knowing both the calorific capacity of the gases and the weight and temperature of the waste gases, it is hardly possible to go very far astray. If the furnace is using too much air, then we cannot but help debiting the boiler with less heat, and the credit of the boiler does not suffer for the faults of the furnace.

With this new method of stating efficiency, the writer has been able to show a real efficiency of about 86 per cent., which corresponded in that particular test with an ordinary efficiency of about 79 per cent. Thus the real efficiency is less than some claims of ordinary efficiency, so that these extravagant figures should not be accepted as reliable.

### Firing for a Test

The main source of error in steam-boiler testing is undoubtedly not the difficulty of measuring the initial and final water conditions, but of ascertaining with accuracy the initial and final conditions of the fire. As regards the water, let a test start and finish at the same gage-glass level and at the same boiler temperature, and there cannot be much quibbling over the weight of water used. But with the fire it is different. To ascertain the rate at which a boiler will perform work when in full going condition, it should have been working at full duty for a time sufficient to have made everything hot, and the test should start when the fireman has just closed the door after cleaning and firing. It should stop after he has just performed the same duty, but he should not know either when he is going to start or when he is going to stop. It is not always easy to manage this with proper water regulation, but of all variables, it would be preferable to calculate the difference of water level. As every engineer knows, water expands with temperature, and with violent ebullition its level must vary somewhat in the gage glass, hence the sense in taking water levels after cleaning and firing, when there is a tendency for the water to be quiet.

### A Boiler Efficiency of over 100 Per Cent.

Even with the best of care, errors will creep in, but it is particularly aggravating when errors creep in so that any one of the published figures of a test turns out to be merely a factor in a claim for over 100 per cent. of real efficiency. Since the furnace may have a temperature of 2500 degrees, and there must be a difference of about 200 degrees between the boiler and flue gas, and the gases pass off at, say, 500 degrees, the boiler being at 300 degrees Fahrenheit, we have offered to the boiler heat to the value of 2200 degrees, and it has refused to take anything less than heat of 500 degrees Fahrenheit. It rejects the last 200 degrees, and so it throws away one part in 11, or 9.09 per cent., giving it a real efficiency of 90.91 per cent. These figures are, of course, merely hypothetical, but serve to illustrate the argument. If a man chooses to run a boiler test at a low pressure, he will simply be required to debit the boiler with so much more available heat; the real efficiency of the boiler will not be improved and no unfair advantage will be taken of the fact.

Stating the results in this improved way aroused interest in the new method, so that several tests were checked, and in one case, at least, certain figures of a test record were changed in order that the impossible result of over 100 per cent. would not appear. But the efficiency must not even approach this figure, and speaking off hand, probably 90 per cent. of real efficiency will be found to be about a maximum. Those who get very high results scarcely give enough thought to the great amount of heat that is lost by radiation, especially when surfaces are badly protected.

### Possible Boiler Efficiencies

After all things have been taken into account it must be admitted that a steam boiler is by no means an inefficient machine. It must not be forgotten that though the heat lost by radiation is debited against it, much of this heat has been already absorbed by the heating surface and is afterwards lost by radiation from the steam drums. Much of it also has never even been presented to the boiler, for it has radiated from the furnace doors and escaped through the side walls.

In considering the question of what is possible in boilers, it may be assumed that the real efficiency and the ordinary efficiency are alike. For this a long boiler is required, and it should be fed at one end with cold feed water and fired at the other end. The flow being counter current, the gases may leave the boiler even colder than the atmosphere, and so the efficiency of heat absorption might be 100 per cent. for both ways of reckoning, but this would require a boiler half a mile or more in length, so that the radiation loss would be enormous. Hence boilers are cut down to a few feet in length. An efficiency of 90 per cent. real or 80 per cent. as ordinarily stated, is about the maximum, and costs are brought within reason. Then cheaper construction in the shape of a separate vessel or feed-water heater serves some of the duty of the boiler tail which has been cut off. A modern boiler is a compromise between the possible and the commercial performances and costs.

Boiler patentees are the men who are primarily responsible for extravagant test results, for they are inclined to offer high fees to the experts, who are not above showing them. The beauty of the real efficiency is, that it puts something of a check on this class of expert, but I am half afraid that, after all, he will find the real efficiency and endeavor to pass it off on his clients as the ordinary efficiency. Let him or them be watched.

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The Wisconsin Power Company is putting down a hydroelectric plant at Kilborne, Wis, for which Wellman, Seaver & Morgan are furnishing four wheels of 2800 horsepower each, directly attached to four generators of 1500 kilowatts capacity, to run under a 17-foot head. There are six 57-inch runners on a shaft for each unit. The development will flood the famous Wisconsin Dells, the water backing up some ten feet.

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The Delray station of the Edison Electric Light Company at Detroit will be extended in the early future by the addition of four 8000-kilowatt Curtis turbine-driven units with Stirling boilers. The latter will be arranged in groups of four backed together so that the central drum is common to two boilers, and fired from opposite sides.

# Economy in Gasolene Engine Operation

## Conditions Which Make for the Most Economical Results; Ratio of Air to Fuel in the Explosive Mixture the Most Active Variable

BY P. F. WALKER

Most of the problems involved in the operation of small gasolene engines have been solved many times, but a certain interest attaches to each new solution and some benefit may be derived from the restatement of a few facts. Emphasis on the reasons for observed results often serves to fix the idea in the mind, and so in the following paper the writer attempts to give a record of the actual conditions which exist in engines of this class while they are giving certain economical results, with the hope that the explanation may serve to impress those interested with the importance of keeping valves correctly adjusted.

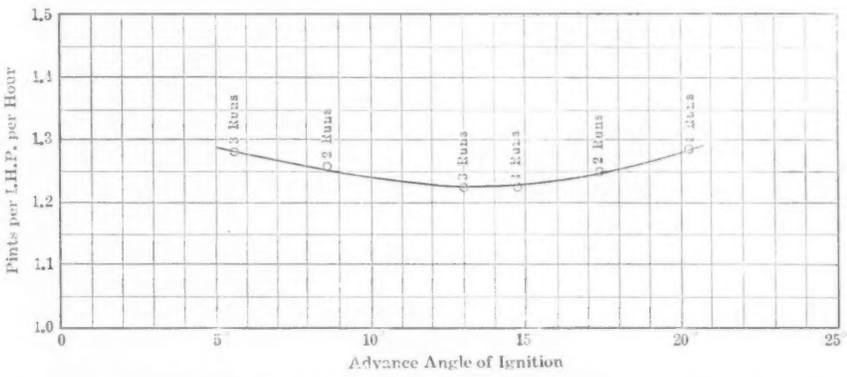



FIG. 1. SHOWING THE EFFECT OF CHANGING TIME OF IGNITION, WITH 60 POUNDS COMPRESSION AND MIXTURE OF ABOUT TEN PARTS OF AIR TO ONE OF GASOLENE

In order to secure good economy with any internal-combustion engine, the mean effective pressure in the cylinder during the working stroke must be high for a given amount of fuel burned in a single explosion. How to secure an expansion line that runs high with the least expenditure of fuel is, therefore, the problem. It is to be noted first that an extremely high explosion pressure may not contribute materially to a high mean pressure. When the combustion is very rapid, and especially if it occurs before the piston moves perceptibly on its forward stroke, as is the case when the igniter is set to spark early, the pressure rises rapidly and the temperature rises at the same rate, since the volume is constant. The high temperature causes heat to pass rapidly to the cylinder walls and thence to the jacket water, and the expansion line on an indicator card taken under these conditions drops quickly into practically the same line as that secured with a slower burning mixture for which the combustion line slopes forward and for which the maximum pressure is materially less. It is true that the high-pressure card has a slightly greater area in the upper corner, and this adds a trifle to the mean effective pressure in many cases, but the cost of securing this small addition of power is an important consideration and one which is not always justified.

The conditions which control the combustion process are the proportion of air to fuel in the mixture, the compression pressure, and the time of ignition. Other factors, which are not so likely to be under the control of the operator, are the speed of the engine, the shape of the combustion chamber, the location of the igniter points and the temperature of the jacket water, but excepting in extreme cases these are not likely to exert an important influence on the shape of the diagram. An investigation of the effects of the three main variables mentioned has been made in the engine laboratory of the University of Kansas with an eight horsepower gasolene engine built by the Olds Gas Power Company, and lent by that company for the purpose of testing, and similar tests are now under way with a Fairbanks-Morse engine using natural gas. In these tests correct measurement of the air used is made by means of two large gas holders alternately filled and emptied. The tests on the gasolene engine were made by William H. Neville and George J. Hopkins.

### Effects of Changing the Ignition Timing

The setting of the igniter in the various tests is indicated by the angle made by the crank with the center line of the engine, below dead-center, at the instant that contact is broken on the igniter points, it being what may be termed the advance angle of ignition. Of course, small angles indicate the later timing and large angles earlier timing.

The most complete series of tests was made with a mixture ratio of about ten parts air to one of gasolene by weight, and with a compression pressure of 60 pounds above atmosphere. Fig. 1 gives the results of this series, several runs being made at each igniter setting and averages being used. Very little variation in fuel consumption is noticeable, all of the results being between 1.22 and 1.28 pints per indicated horsepower-hour, but

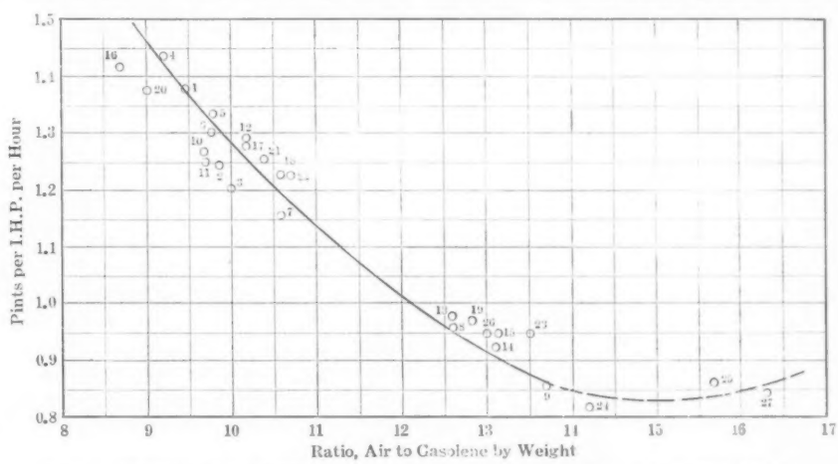
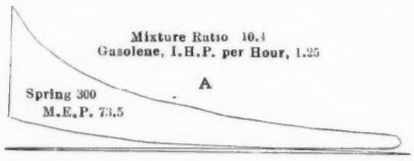



FIG. 2. SHOWING THE EFFECT OF CHANGING THE MIXTURE. THE CURVE REPRESENTS IGNITION AT 13 DEGREES ADVANCE

the slight curvature of the line indicates best results near the 13-degree setting. With the larger proportion of air in the mixture the results secured do not make a regular curve, but in Fig. 2 the curve, which is drawn through points established by records with the igniter set at 13 degrees advance angle, runs below all other points near the mixture ratio of 13 parts of air to one of gasolene, thus confirming the conclusion that the best setting is near 13 degrees. Slight differences are noticeable, however, and the general conclusion is that it is immaterial where the igniter is set between 10 and 17 degrees.



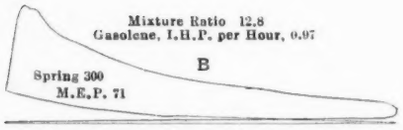
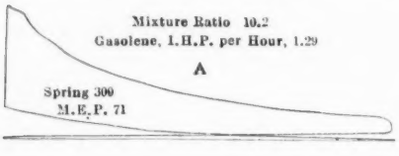




FIG. 3. GASOLENE DIAGRAMS, WITH IGNITION AT 17.3 DEGREES

The influence of time of ignition on the shape of the diagram is seen by referring to Figs. 3 to 6. Diagrams *A*, in Figs. 3, 4 and 5, and both of those in Fig. 6, show mixture ratios of about ten to one. Following the vertical combustion line of Fig. 3, with 17.3 degrees ignition advance, this line begins to slope forward as ignition occurs later and becomes curved with the ignition at 5.6 degrees. A tendency is apparent for the mean effective pressures to increase with delayed ignition, the same tendency being shown in diagrams *B*, Figs. 3, 4 and 5, where similar forms of diagram are produced with relatively earlier ignition by reason of the leaner mixture. It should be understood that the mean effective pressures given for these diagrams are the average values found for all the cards taken during the several tests, and may not always apply exactly to the representative diagrams shown, since these were selected more with a view of showing typical curves than to represent average quantities.



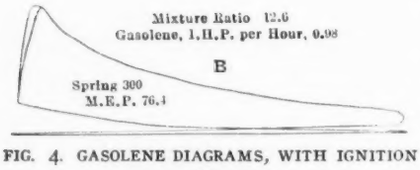
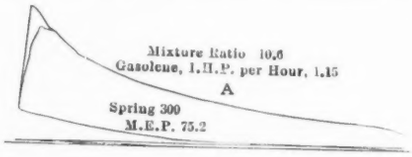
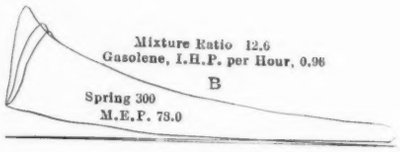




FIG. 4. GASOLENE DIAGRAMS, WITH IGNITION AT 14.8 DEGREES

### Effects of Changing the Mixture

In order that the maximum heat value of the fuel may be utilized, a sufficient supply of oxygen must be present to unite with the combustible elements. The amount of air of the standard proportion of oxygen and nitrogen required to burn completely one pound of gasolene is very nearly 15.33 pounds. Similarly the amount of air required to burn 1 pound of denatured alcohol, made up of 90 parts of grain alcohol and 10 parts of wood alcohol, with a small portion of benzine, is 8.41 pounds. At standard atmospheric pressure of 14.7 pounds per square inch, and at 62 degrees Fahrenheit, these values are equivalent to 155 cubic feet of air per pint of gasolene, and 93.5 cubic feet per pint of alcohol.



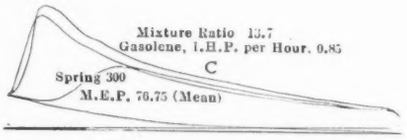
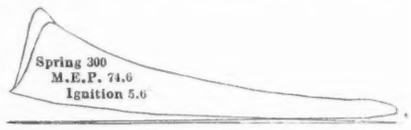




FIG. 5. GASOLENE DIAGRAMS, WITH IGNITION AT 13 DEGREES

The rapidity of combustion depends upon the thoroughness with which the air and combustible are mixed, and the unanimous testimony of the sets of diagrams shown in Figs. 3, 4, 5, 7 and 8 is that the richer mixtures burn more rapidly. With the engine operating at 60 pounds compression, the leanest mixture that could be employed satisfactorily was with 13.7 pounds of air to one of gasolene, a diagram for which condition is shown in Fig. 5. By raising the compression to 80 pounds a mixture ratio of 16.3 was successful, which is more air than is required for complete combustion of the fuel. The diagram for this condition, shown in Fig. 7, is seen to be almost identical in form with the one for the 13.7 mixture at 60 pounds compression. It should be explained that the very low combustion line which appears once on each of these two diagrams is that resulting from the first explosion following a "miss," under the action of a hit-and-miss governor. The scavenging stroke cools the cylinder and also changes the mixture ratio slightly for the next charge, both conditions tending to retard combustion. In finding the average mean effective pressures it is necessary to take into account the number of these low diagrams during a test, which is equal to the number of misses made by the engine.



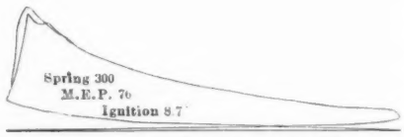
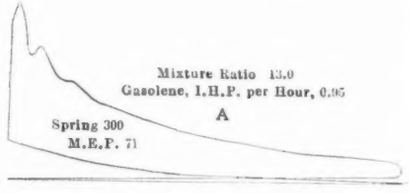




FIG. 6. TYPICAL GASOLENE DIAGRAMS, WITH LATE IGNITION. MIXTURE RATIOSS 9.4 AND 9.75. GASOLENE, I.H.P. PER HOUR, 1.28 AND 1.26

The effect of varying the mixture on economy is shown plainly in Fig. 2. The curve is drawn with reference to points 4, 5, 6, 7, 8 and 9, all of which indicate results secured with the igniter set at 13 degrees angular advance, and it is representative of the general principle involved. As has already been stated, the leanest mixture that could be used with the compression of 60 pounds above atmosphere was with a 13.7 air ratio, shown at point 9: it is evident, therefore, that this com-



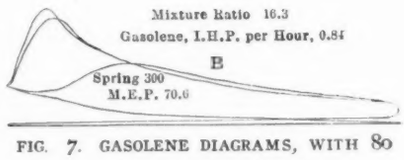




FIG. 7. GASOLENE DIAGRAMS, WITH 80 POUNDS COMPRESSION

pression pressure is not high enough for the most economical working of the engine. With compressions of 70 and 80 pounds gage, however, mixtures up to 16.3 parts of air are readily handled, as seen at points 24, 25 and 27, extending to proportions which are beyond the ratio giving best economy at the two points last mentioned. Points 23 and 26, which represent, respectively, compressions of 70 and 80 pounds above atmosphere, fall near values with 60 pounds compression, and this fact, together with the location of point 24 and some other values not shown in Fig. 2, leads to the opinion that increasing compression is principally useful in permitting the use of leaner mixtures, and that in this class of engines, at least, the most important factor in economy is the ratio of air to the combustible in the explosive mixture.

### The Effects of Changing Compression

Unfortunately the records found for compressions higher than 60 pounds gage were insufficient to be conclusive. At 80 pounds gage the engine gave trouble from pre-ignition of the charge, and only two satisfactory runs could be obtained, these being with the leanest mixtures, which are ignited with the greatest difficulty. These results are shown at points 26 and 27, Fig. 2. At 70 pounds, or 85 pounds absolute, the engine operates well, but several of the results secured were inconsistent and time did not permit of a complete investigation. Points 23, 24 and 25 are the only values usable at this compression, and they are not entirely satisfactory. The extension of the curve in Fig. 2 into the region beyond point 9, as is done in the broken line, is warranted only by general considerations, but the condition indicated is a reasonable one, with the best economy secured with a mixture ratio of about 15, when the theoretical ratio is 15.33. Just what the minimum fuel consumption would be is not strictly defined, but the general form of the curve is fully justified.

### The Mean Effective Pressures

As was said in the beginning, a good test for economy of an engine is a comparison of the mean effective pressures obtained for given amounts of fuel consumed. Fig. 3 is a good illustration of the point first mentioned, the diagram *A* having a vertical combustion line and a slightly higher mean effective pressure than diagram *B*. Dividing each mean effective pressure by the amount of gasolene used for explosion, however, and taking the result for diagram *A* equal to unity, the corresponding value for diagram *B* is 1.29. That is, in proportion to the amount of gasolene used, changing the mixture from 10.4 to 12.8 increased the mean effective pressure 29 per cent. Similarly in Fig. 5, comparing diagrams *A* and *C*, increasing the mixture ratio from 10.6 to 13.7 bettered the mean effective pressure 35 per cent. on the economic basis. And in Fig. 8, on the two diagrams for alcohol with 20.2 degrees ignition, changing the mixture from 7.3 to 8.1 raised the comparative mean effective pressure 9 per cent., although the actual pressure is less.

### The Work with Alcohol

A very few short tests were made with alcohol for fuel, not with the idea of determining the best conditions for using denatured alcohol, but simply to observe results when that fuel is used in the ordinary gasolene engine. The only change made in operating conditions was to preheat the alcohol to about 90 degrees

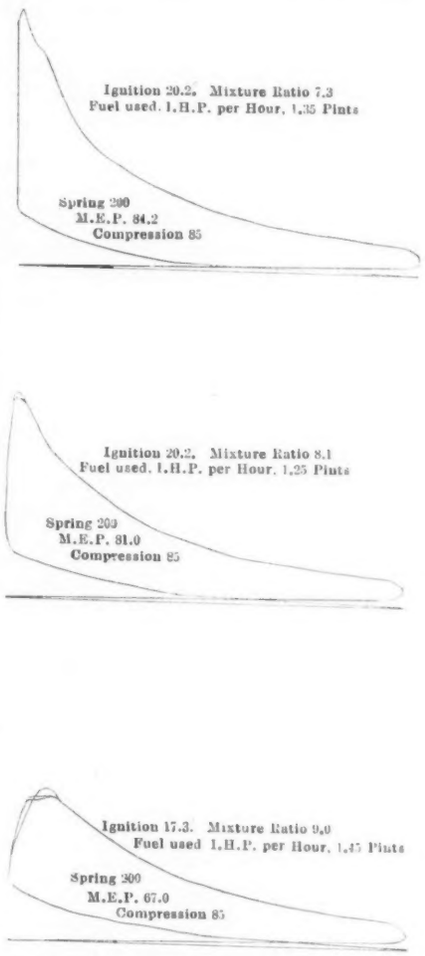



FIG. 8. TYPICAL ALCOHOL DIAGRAMS

Fahrenheit, which is easily done with the exhaust gases, and to raise the compression pressure to 85 pounds gage. A higher compression would have given better results, but the means of securing the proper amount were not then available. Expressed in heat units the results secured were 12,740 B.t.u. per indicated horsepower-hour, as compared with 12,660 for gasolene at 60 pounds compression. Both values would be bettered by using the compression pressure which would permit the use of the best mixture ratio, and under appropriate conditions with the design of the engine fully worked out for the use of alcohol, that fuel would have the advantage on the heat-unit basis.

### Conclusions

The investigations outlined, while incomplete in respect to varying compression, show conclusively that the most active variable in gasolene-engine economy is the ratio of air to fuel in the explosive mixture. With the compression pressures ordinarily employed, it follows from all the information secured, that the gasolene-admission valve should be closed down to the lowest possible point at which the engine will carry the load upon it. By thus adjusting the valve to the load, always keeping the supply as small as possible, the fuel consumption will be kept at the lowest point possible for the compression employed, in spite of the fact that the indicator card may show a form of combustion line materially different from that usually supposed to represent ideal conditions.

## Garbage for Fuel

At Birmingham, Ala., a new process of converting garbage and other refuse into fuel has been tried recently, with reported success. The system is the invention of Andrew Engle, of Des Moines, Ia., and is believed to be an improvement over other processes, which have been in vogue in England and elsewhere for several years. Chemicals mixed with lime and coaldust are used to prepare the refuse and the fuel thus provided is said to make an excellent fire.

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According to a report by Prof. G. Weber in a German contemporary, efficiency tests of a Diesel motor of 200 horsepower, driving a direct-coupled three-phase generator in the power plant of the foundry of the L. von Roll Ironworks, at Berne, showed the following results: Fuel used, petroleum residuum. Fuel consumption in pounds per kilowatt-hour at switchboard, 0.62 at maximum load, 0.62 at rated load, 0.66 at three-quarter rated load, 0.77 at half rated load, 1.42 at quarter rated load. The generator efficiency varied from 91.5 per cent. at full load to 77.5 per cent. at quarter load, including friction and ventilation losses at 1 per cent. of full load. The thermal efficiency based on effective horsepower was computed at 33.6 per cent. for rated load, 32.4 for three-quarter load, 28.7 per cent. for half load, and 18.7 per cent. for quarter load, while the thermal efficiency based on indicated horsepower was 47.3 to 44.1 per cent., being maximum at half load.—*The Engineer.*

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The managers and superintendents of large office buildings have a National Association which met at Chicago during the week ending August 15. In addition to questions concerning the renting of space, costs of lighting, heating and elevator service were discussed.

# Practical Letters from Practical Men

**Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other**

## WE PAY FOR USEFUL IDEAS

### Saved the Packing—Commutator Turning Device — Electric Gage Alarm

On looking over the stock of packing when taking charge of my present plant, I came across a large box of ring packing. I was told that it belonged to an old, discarded engine, and would not fit anything on the place. I soon discovered it was an exact fit for the piston rod of the small engine, but was 3/16 inch too small for the stuffing box. I soon hit upon a plan by which I could use it. I took some 3/32-inch sheet-rubber packing and cut a strip as long as the circumference of the stuffing box and as wide as the depth, and slipped this inside the box and the rings inside of it. This strip had to be renewed or added to each time the packing was renewed, as the follower pushed it in with the packing. This gave better results than the regular packing, and helped my packing bills out considerably.

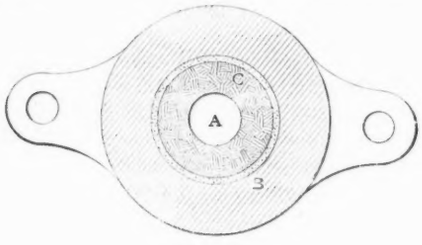



FIG. 1

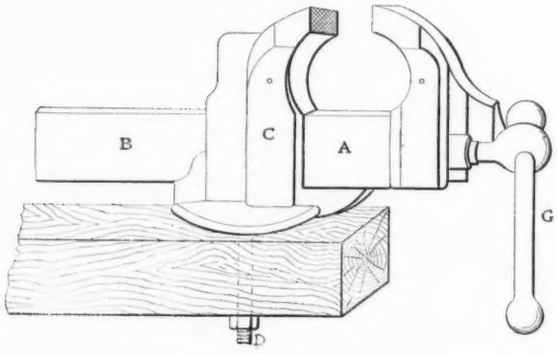
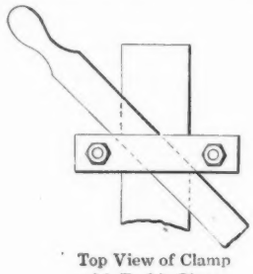


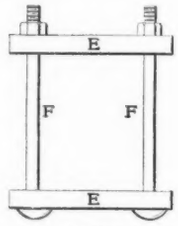

FIG. 2

In Fig. 1, *A* is the piston rod, the ring *B* is the sheet rubber and *C* is the ring packing. The illustration is an end view of the stuffing box.

The following arrangement which I fixed up for turning a commutator is one that can be made in most any plant having no better means for doing the job. We had an iron vise, Fig. 1. The front jaw *A*, Fig. 2, has a tail-piece *B* extending through and some distance beyond the back jaw *C*. I first solidly fastened a timber under and to one side of the commutator. Then boring a hole through it in the proper place, the vise was fastened to it by the bolt *D*. I then made a clamp of the two pieces of iron as *E*, and two bolts *F*. The length of the bolts and distance the holes are apart depend on the size of the tail-piece of the vise *B*. This clamp was slipped over the top of the tail-piece, with the tool between the two, thus making a fair adjustable tool-post, which can be fed crosswise by the handle *G*. To regulate the chip, loosen up the clamp slightly and drive the tool with a hammer. Fig. 3 shows a top view of clamp with the tool in place.



Top View of Clamp with Tool in Place.




Clamp

FIG. 3

I have an ice plant and cold storage in connection with the electric plant, the compressor auxiliaries being in a separate room from the engines and dynamos and, therefore, are not under constant surveillance. We use a belt-driven centrifugal circulating pump, and if anything happens to it, it doesn't take long for the condensing pressure to get to dangerous extremes. After a couple of hair-raising experiences of this kind, one of which came just after getting home from a hard day's work, making it necessary to go back and work all night, I decided to rig up some kind of an alarm to give notice of any undue rise in pressure. I naturally turned to electricity for it. There have been many kinds of electric alarms described in the past, but I have seen none like the one I made for this place.

I drilled a hole in the top of the high-pressure gage a little to the right of the center, and so that it would come into the space between the dial and the glass face just above the 210-pound mark. I then secured an insulating bushing to fit the hole and passed a small, bare copper wire through it, bent in such a shape that the hand would rub on it from the 210 mark and upward. Using this wire for one terminal and grounding the other on the gage made an automatic switch which will close as soon as the pressure reaches 210 pounds, and open when it gets below.

I then put a bell in a prominent place in the engine room, connected it in series and took current from the lighting circuit. The bell I used was a polarized bell with 1000 ohms resistance, therefore I did not need lamps in series. In a plant where there is no 24-hour lighting current, a vibrating bell and batteries could be used as well.

CHARLES E. BECKWITH.

Ritzville, Wash.

### A Pump Question

In the plant where I am employed there is a boiler feed pump of medium size that has never given good service. It takes water from a well 6 feet deep through a 1½-inch suction pipe 22 feet long and discharges into a tank some 200 feet from the power house and about 150 feet in the air. Discharge and suction pipes are of the same size. I put an air chamber on the suction line about a foot from the pump, which was of the same diameter as the suction and 2 feet high. Since making the change the pump works satisfactorily with a steady full stroke and with less than one-half of the steam it formerly took. There were no leaks in the suction-pipe pipe. What caused the difference in the action of the pump? Was it the air coming up with the water that caused it to work hard, or did the suction air chamber have the same effect that a larger suction pipe would have?

F. B. DUNBAR.

Hesperus, Colo.

## Running Water Wheels and Engine on Same Line Shaft

On page 39 of the July 7 issue of POWER AND THE ENGINEER, an inquirer asks for information regarding the running of water-wheels and engines on the same line-shaft. We have a plant here of four 125-horsepower water-wheels and a 500-horsepower compound engine connected just as he desires to connect up his engine. When there is plenty of water the engine is off altogether; when water is low, the engine is put on and enough water is shut off from the wheels to keep the head of the water at the top of the dam. When the engine is put on, the governor on the water-wheels is cut out, allowing the engine governor to control the speed of the mill. With the water-wheel governor in use, we found it impossible to so adjust the speed that it would either put all of the water on the wheels or shut it all off, depending, of course, as to whether the speed of the engine was slower or faster than that of the water-wheels.

W. A. FIELD.

Anoka, Minn.

## Emergency Motor Repair

Some time ago the writer was called upon to repair a motor hoist working on a large department store in course of erection in this city. The motor was an ordinary 5-horse-power, 200-volt, shunt-wound machine, driving a drum through worm gearing, and controlled by a Cutler-Hammer reversible controller, the whole being mounted on a bed-plate on wheels.

On arrival I was told by the foreman builder that there were sufficient bricks at hand to last 20 minutes, and if the machine was not running within that time the men must be put off. It was soon seen that the brushes had worn so low that the springs no longer brought any pressure to bear on them (the holders being of the box type), and simply rested on the commutator by their own weight, or not at all. The commutator was quite black, and so hot that the solder had commenced to run from most of the lugs.

When the machine did run (which it did intermittently) the brushes arced so that the points glowed like an arc-lamp carbon on switching off, and had become somewhat similar in shape at the points. They were quickly removed and set aside to cool. The commutator was cleaned up with sandpaper, the brushes replaced with the top ends down, a piece of wood packing placed on top to bring the spring pressure to bear, then (approximately) fitted with a sheet of sandpaper and the machine started well within the time. It continued to run satisfactorily until an opportunity arrived of fitting a new set of brushes.

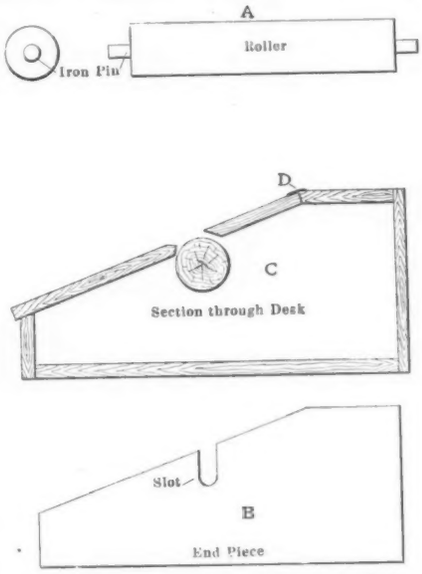
F. A. MCINTOSH.

Adelaide, S. Australia.

## Keeping Report Sheets Clean

In modern, up-to-date power stations it is necessary to keep a daily report of the day's run, and the engineer frequently has to lay down his tools to attend to the report. The result is a besmeared report sheet which is unfit for the office files. The report must be copied with clean hands, or go to the office in its filthy condition, which creates a bad impression. If copying is resorted to, the task is considerable and mistakes are easily made.

A desk as shown in the accompanying sketches will, if used, enable the engineer to keep a clean report without the necessity of washing his hands when each entry




DETAILS OF DESK FOR KEEPING REPORT SHEETS CLEAN

is made. The desk is easily constructed, the only part requiring any special work being the roller, which is turned out of wood.

Referring to the sketch, *A* is a roller of sufficient length and circumference to accommodate the blank report sheet, the blank being wrapped around the roller and held securely by small rubber bands. Iron pins are set in the center of the roller at each end as shown. These pins rest in the slots in each end of the desk, the end pieces being made as shown at *B*.

In the lid of the desk is cut a slot directly over the roller and the full length of the same. Through this opening entries may be made on the report with the hand resting on the lid of the desk. The roller may be turned to bring the proper place on the sheet under the opening. At *C* is shown a section through the desk and the position of the roller under the opening in the lid. The lid is hinged at *D* and is raised to put the roller in place. The space below the roller may be used for extra report sheets, charts, etc. The desk may be fastened to the wall or legs may be added, as in the ordinary desk.

C. L. GREER.

Handley, Texas.

## Wire Belt Lacing

For the past four years I have used only wire lace. The lacing machine is permanently fastened in one place, the belts are taken to it, and when prepared, may be put on the machine they belong to almost instantly by the insertion of the rawhide pin. A good lacing method should be rapid and lasting; it should not destroy the belt, and the joints should run noiselessly. All these qualities are possessed by the wire lace.

In putting on a new belt I always put in a piece about 2 inches long, which can be taken out when the belt has stretched. I have laced belts with wire, from 14-inch double down to 1-inch single, and the wire lacing was all right.

One objection to wire lacing is that the ends of the wire sometimes project, and when belts are shifted by hand these points may cut the hand. They should be forced into the leather when applied.

J. C. MILLER.

Oak Park, Ill.

## How Should the Heaters Be Connected Up?

There is a discussion now on between a consulting engineer and myself concerning some heating arrangements for candy kettles and coils. Plans are under way for the re-construction of a candy factory that recently burned down, upon the four floors of which will be steam-heated cooking kettles and warming coils. This will be the only use for the 80-horse-power boilers that are being installed, as it has been decided to drive all machinery by individual electric drive. The consulting engineer contends that each heater or cooking vat should be fed from one line and trapped to a return which is pumped back into the boilers. This entails the expenditure of more than $1000 for the necessary auxiliary apparatus.

The other contention is that since all these heaters and cookers are above the boiler, the only necessity is to put in our feed lines so as to drain the heaters and let the condensation run back into the boiler, thus eliminating all traps and other similar apparatus with their large possibilities of leaks and losses. Can this be done successfully? Thus we would have a closed boiler with one heater and feed-water heater troubles reduced to a minimum. What do POWER AND THE ENGINEER readers think of it?

F. H. NEELY.

Wilkinsburg, Penn.

## What Wrecked the Engine?

On June 30, at about 12 o'clock, a 16 by 20-inch high-speed engine in the power plant of the Lord Baltimore Press in Baltimore went to pieces. The engine was comparatively new and running along smoothly with a moderate load when the attendants were attracted by a tremendous banging, and before the engine could be shut down the cylinder-head was blown out and driven through the switchboard. The crank-pin box studs were both broken squarely off. The connecting-rod was bent to an angle of about 90 degrees and the crank-case split longitudinally with a section of the top guide broken out. The piston-rod nut was stripped and the piston dropped out the open end of the cylinder onto the floor. At the time of the writer's visit to the plant there were as many conjectures as to the accident as there were men present. There were but two gages of water in the boiler at the time. The engine was direct connected to a direct-current generator. I should be glad to hear the probable solution from some reader of POWER AND THE ENGINEER.

EDWARD T. BINNS.

Philadelphia, Penn.

## Evaporation and Superheat

Sometime ago I had the opportunity of making a test of a battery of boilers which had recently been installed. The test was conducted for the purchaser to ascertain the operation, rating and evaporation, before final acceptance.

The results of two tests, one at rating and one at 150 per cent. rating, showed a quite low evaporation from and at 212 degrees Fahrenheit. On taking the matter up with the boiler manufacturers, and asking that they endeavor to improve on this before our final acceptance, we had our eyes opened to a feature that, it seems, will bear discussion, and one which should be more generally understood and clearly defined in making contracts for boiler performance.

In reply, the manufacturers claimed we had been in error in our calculation of evaporation from and at 212 degrees Fahrenheit, as we *had not included the heat given up to the steam in superheating.*

On this basis they quoted new figures for the evaporation as per our tests and these were an increase over ours of some 7 per cent.

Can anyone point to a previous discussion on this matter?

Will boiler manufacturers state their position?

It seems that if the boiler people are using the heat given up in the superheater to raise the "from and at" figure, why should not the heat absorbed by the water in passing through an economizer be likewise used?

My idea of a superheater is that it be so constructed and located in connection with a boiler as to take up the work where the boiler left off and carry it on, rather than have its work counted in with the boiler, as an evaporator of water.

F. H. NEELY.

Wilkinsburg, Penn.

## Truing a Crank-pin — Telling the Difference between Iron and Steel

In a recent issue of POWER AND THE ENGINEER was illustrated and explained an excellent method of removing a crank-pin, which reminded me of a case I was called upon to rectify some years ago. It was a 100-horse-power Corliss engine, nearly new, but had knocked ever since it was erected. I tried everything I knew or had heard of before dismantling the engine, which was found both in line and level.

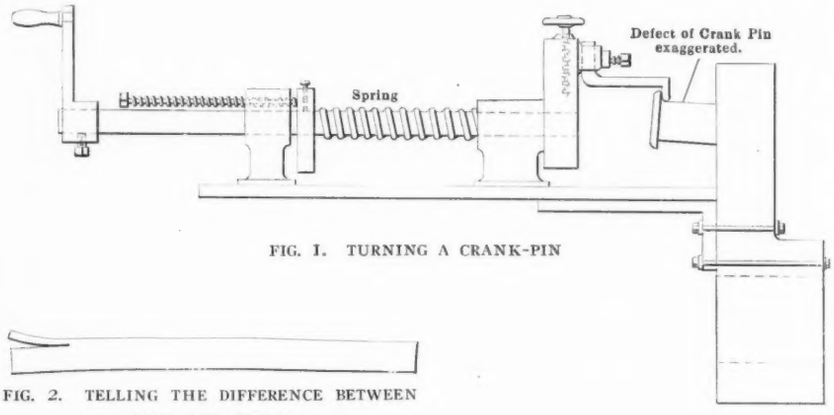



FIG. 1. TURNING A CRANK-PIN



FIG. 2. TELLING THE DIFFERENCE BETWEEN IRON AND STEEL

The crank-pin was next put on the dead center and the connecting-rod keyed tight to the crank-pin, leaving the cross-head brasses and strap off, the stub end lying on a smooth flat plate so it would not be strained out of its position by reason of being keyed tight to the crank-pin. Measurements were then taken from the side of the stub end to a planed portion of the guides, and the crank-pin then turned to the other dead center, when it was found that the stub end was out 3/4 inch. This was verified before being accepted as correct. This showed that the crank-pin was not square with the crank. This could also be noticed by using a 6-inch square.

As the pin was evidently shrunk in the crank good and tight, I concluded to rig up a device for truing the pin in place as shown by Fig. 1. An angle-plate was clamped to the crank, and two parallel bars bolted to it, using two ordinary clamp boxes and a piece of 2-inch shafting for a bar. To this was bolted a hand facing tool in which was inserted a stiff goose-neck turning tool, as shown. The spring shown was wound open so as to allow about 8 inches of compression between the set collar and the box. The long threaded screw, 3/4 inch in diameter, was turned on the end to 5/8 inch to fit a hole in the loose collar and hold it when the bar with the set collar was revolving, the spiral spring preventing the goose-neck tool from "pulling ahead."

It required about five hours in the shop to get out the rigging and five hours more to set it up. The turning took less than two hours, as the pin was only 3/64 inch smaller after it was filed and finished, which was considerably cheaper than removing the old pin, reboring the crank, making a new pin and paying for the new material. Best of all the knock had disappeared when the engine was started up.

I also noticed an excellent description of a method to tell wrought iron from steel, suggested by the Reading Iron Company on page 941 of the June 16 issue. The average machinist, however, cannot make use of it because he has not the facilities or ingredients at hand, neither has he the time, as he wants to use the material immediately and must know at once, hence the method is only applicable in the laboratory.

An old method used repeatedly by the writer and others, is to take a keen cold chisel, and turn up a chip similar to that shown in Fig. 2, hit it on the end with a hammer and bend it over; if it breaks off short and the grain is close and bright in appearance it is steel; if it bends and finally breaks leaving ragged edges and open grain it is iron. This test does not require five minutes, and the writer has found it absolutely reliable whether used on pipe or bar iron.

W. S. LUCKENBACH.

Leavenworth, Kans.

## Setting the Slide Valve

For simplicity, a valve without lap or lead will be considered and one having a direct motion. When the crank is on either dead center the eccentric is 90 degrees ahead, or at right angles to the crank if the engine is to run over, and the valve is central in its travel, as shown

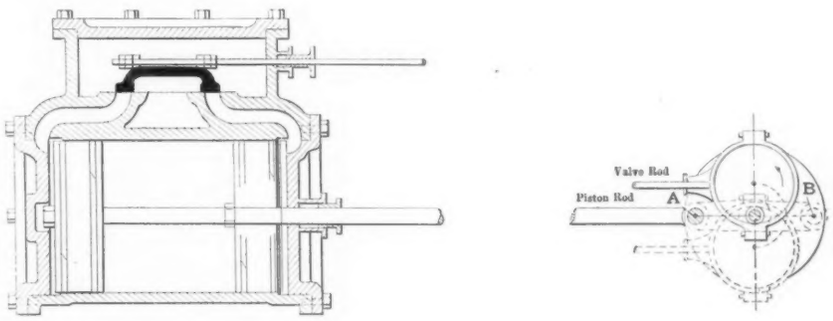



FIG. 1

in Fig. 1. When the crank is at 90 degrees or at half stroke, the eccentric has reached its outward dead center and the steam port is wide open. See Fig. 2. When the crank reaches its outward center, the eccentric has reached one-half its return stroke and the valve is at its center of travel.

Let the engine be stopped and the position of the eccentric marked on the valve rod opposite the gland when on the dead center. Then turn the engine until the eccentric is on the other dead center and again make a mark on the rod opposite the gland. These two marks are to show the position of the eccentric should it be desirous of running under at any time.

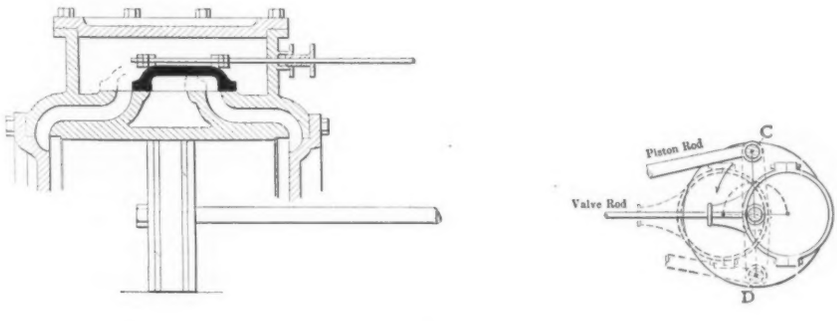



FIG. 2

Ignore the position of the crank and let it remain where it is at half-stroke, loosen the eccentric and turn it in the direction the engine is to run until the first mark comes opposite the gland, when it will be found that the valve has opened the crank-end port and the engine will run under.

P. E. MERRIAM.

Lawrence, Mass.

## Automatic Feed Water Regulators

The automatic feed-water regulator is an appliance that seems to be installed with a feeling of more or less distrust, due no doubt to the accidents that have been caused, or supposed to have been, by low water in boilers in which the water level was controlled by hand.

To the best of the writer's knowledge there is no record of a boiler explosion due to a faulty regulator, or of a boiler on which a regulator has been installed. As far as the argument that it has a tendency to make the boiler-room force careless is concerned, I would say that I have charge of eight 275-horse-power of boilers equipped with regulators, and know of several plants in which they are installed, and can see no difference in the watchfulness of the men handling the boilers, either before or after they had made the change from hand regulation.

The advantages of this appliance are all due to the constant water level and perfect reliability; in short, they include safety, economy in both fuel and labor, and dry steam, which is the prime reason for installing a regulator. The factor of safety is at once apparent, and in connection with the high-and-low-water alarm the device is as nearly infallible as it is possible for human ingenuity to make it. The water, as a general rule, is carried at the second gage, and in a water-tube boiler of the Babcock & Wilcox type this brings it to the center of the drum, which practice seems to be accepted as most economical. The high-water alarm is set at the third gage and the low-water at the first gage, so that in case of the regulator refusing to act, it will always allow plenty of time to rectify the trouble before any serious consequences occur. I do not wish to be misunderstood regarding my position on this matter, so would say that a regulator is a piece of apparatus that must receive the same care as any other part of the plant; a regulator would be as unreliable as any other machine, if neglected. A regulator or water column of any type should be blown down every three hours to clear it of any scale and also to make certain that the alarm feature is in working order.

The economy in fuel is brought about by the uniform water level, thus keeping a practically constant temperature on all parts of the boiler, except, of course, the furnace and the setting around the furnace, which are designed to withstand the varying temperatures more than the steam spaces.

Any good type of regulator can be depended on to admit the feed water into the boiler as soon as there is the slightest fall in the level, thus doing away with the chances of the water falling low suddenly and making it necessary to force the fire while raising the level to normal.

Another point against the regulation of feed water by hand is the tendency of water tenders to carry the water too high for the sake of safety, thus having to heat a larger body of water to no advantage. I have often noticed in boiler rooms, especially around steel mills, where a very variable load is carried, that as soon as a large engine of 3000 or 4000 horse-power capacity is suddenly thrown out of service, the first move is to start the feed water into the boilers to check the steam; then when the full load comes on again it is a case of forcing the boilers to the limit to hold the steam pressure with a high-water level. A regulator would not do away with this entirely, but the boiler-room force would be more liable to have the fires under better control and the boilers would respond more readily to a quick change in load with a uniform water level than when the level varies.

Dry steam is a factor that is very much in demand in design and operation of power plants, more especially where steam turbines are installed, as they show a greater economy on dry steam than an engine under like circumstances. It is also desirable on account of danger of damaging the blading by slugs of water coming over in the line when wet steam is used.

In summing up these few remarks I would say that I have formed my good opinion of automatic feed-water regulators only after a thorough trial extend-

ing over a period of a year or more. We can depend on our regulators to hold the water within a half inch of a certain level and have had practically no trouble or repairs.

C. A. CRYTSER.

Hammond, Ind.

## Current Consumption of Induction Motors

Regarding the problems propounded by L. A. Thompson, in the June 23 issue, as to the "Current Consumption of Induction Motors," I think many engineers fail to realize what the load consists of in the running of centrifugal pumps, and why, as Mr. Thompson notes, it takes less power to operate the pump when the discharge is closed and the pressure is higher on the discharge pipe than with the discharge open wide and the pump working at full capacity.

Let us take, for example, a centrifugal pump, with 10-inch suction and 8-inch discharge, revolving at 290 revolutions per minute and pumping 3000 gallons per minute, the hight of lift being 15 feet. Allowing 8.34 pounds per gallon of water pumped, we have

$$3000 \times 8.34 = 25{,}020$$

pounds per minute. Multiplied by the 15-foot. lift we have

$$25{,}025 \times 15 = 375{,}300$$

foot-pounds of work. Divided by 33,000, we have

$$\frac{375{,}300}{33{,}000} = 11.4$$

horsepower. Add to this 15 per cent. for friction in suction pipe and ells, and we have 13.1 horsepower actual work done by the pump. Taking the manufacturer's estimate of 1.35 horsepower for each foot of lift, then

$$15 \times 1.35 = 20.25$$

horsepower. The 7.15 horsepower difference between the manufacturer's estimate and the actual work performed can be charged to friction in the bearings, stuffing box and the revolving arms within the casing carrying the confined water around with it.

With current at 220 volts, 20.25 horsepower will take 68 amperes and 13.1 horsepower will take 44.5 amperes. The difference, 23.5 amperes, represents the friction of the pump with the discharge closed tight. For, when the discharge is closed tight, the only work the pump has to do is to revolve the water contained in the pump casing, and the friction of its bearings.

If Mr. Thompson would plug his circulating-pump discharge tight some time when he has the condenser head off, and then run his pump, he would probably find that his motor would take only a little over 20 amperes of current. Probably he has a partial vacuum in his discharge pipe when his condenser pipes are clear on account of the siphon action of the discharge from the condenser. Its lower end being below the condenser, say from 10 to 15 feet, would give him from 3 to 5 inches of vacuum, depending on the temperature of the water.

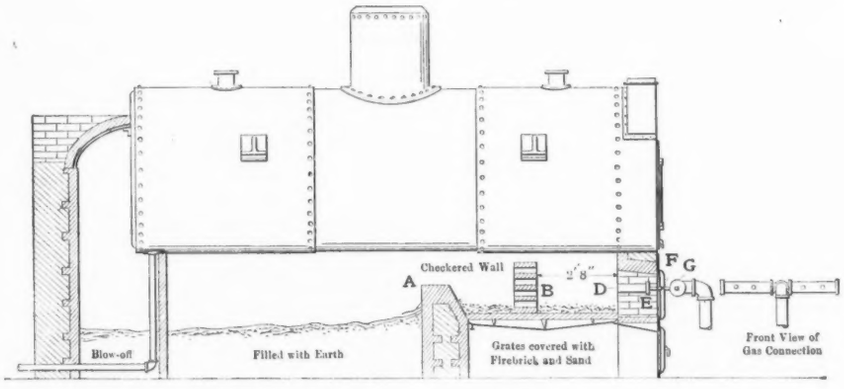
Probably Mr. Thompson will also find when he starts his air pump that by closing the drips on the idle unit the same as when it is in operation, the current consumption will be less than 20 amperes. It is the quantity and weight of the water discharged from a pump, at a given pressure, that represent the work performed.

GEORGE H. KELLOGG.

Syracuse, N. Y.

## Natural Gas Burner

In a recent number of POWER AND THE ENGINEER, F. Remington requests the general lay-out of a gas-burning system. The following is a description of a good installation for low-pressure gas of from 2 to 5 ounces:




A NATURAL-GAS BURNER

In the illustration, *A* is a bridgewall, *B* a firewall consisting of four rows of checkered brick, and *D* is a combining tube where the air and gas mix before entering the furnace. The combining tube is a piece of 4-inch pipe, 12 inches long, set in the center of the fire-door, which is bricked up; *E* is a ¾-inch cap perforated with 1/16- or 3/32-inch holes to break up the gas to mix with the air. The cap should be about flush with the funnel and in line with the center of the tube. At *F* is a ¾-inch pipe and valve, which are attached to the manifold *G*, which is made of 6-inch pipe with the necessary tee and ell; there is also a top view shown.

The funnel on the combining tube is made of heavy galvanized tin and fits inside the 4-inch tube. The grate-bars are covered with brick, laid flat, and sprinkled with sand. We use four burners to each boiler, which are 80 horsepower. The object of the firewall *B* is to break up the flame and throw it toward the shell of boiler. The size of the smokestack for a 100-horsepower boiler should be 30 inches in diameter by 70 feet high.

J. A. CAMPBELL.

Burgettstown, Penn.

In reply to Frank Remington's request for information regarding an equipment for burning natural gas, I would suggest that the only change necessary to burn it in a furnace that has formerly burned coal is to place a layer of fire-brick flatwise on top of the grates and lower the bridgewall about 3 inches below what is generally considered good practice with coal.

It is well to leave the smokestack with its original area, but its hight should be reduced one-half, and if surrounding buildings permit, it can be reduced to one-third of its former hight. There are several good makes of burner on the market; the one that seems to give the best results delivers the air and gas with a whirling motion, thereby getting a thorough mixture, which is essential to complete combustion.

To install this type of burner, the fire-doors should be removed and, for a 100-horse-power boiler, two burners should be bricked into each fire-door, making four burners to each boiler of a size requiring a 1¼-inch pipe connection.

The header should be a 4-inch pipe and should run just under the floor line in front of the furnaces, with the 1¼-inch pipe as risers, each fitted with a valve.

The regulation of the gas to the burners is very important and is best accomplished by an automatic regulator, actuated by the change in steam pressure, thereby admitting just the amount of fuel necessary for the work being done.

In comparing natural gas with coal it is safe to estimate the gas at 30,000 to 34,000 cubic feet to equal one ton of coal. Natural gas varies considerably in heat units per cubic foot, but averages about the same as methane gas, $CH_4 + 2O_2$, having 966 B.t.u. per cubic foot, and this could be used as a fair basis for comparison with the B.t.u. in coal per pound.

By installing a suitable regulator and burner, Mr. Remington can obtain an almost perfect automatic firing apparatus and one that will maintain a beautiful steam chart with minimum attention.

T. A. SECORD.

Bartlesville, Okla.

## Do It Now

I think the editorial, "Do It Now," in the July 21 number, was just the thing required to stir up a lot of us fellows. In a large plant the chief engineer generally finds enough to do looking after his men and the work and seeing that everything is run carefully and as economically as possible with proper service. He has, therefore, no time to do any manual work personally, neither is it expected of him. I believe, however, that one walking boss around the average plant is enough.

Some months ago I wrote an article for an engineering paper in which I said, in part:

"Many small steam plants contain only a small horizontal boiler, one steam engine and a feed pump. The engineer has anthracite for fuel, and he would probably have about three hours' work each day if all his working times were bunched together. Surely, it would not be out of the way if he were asked to do any small job which would not necessitate his absence from the engine room."

In the next issue I got it good and hot from several engineers (names not signed). I was told that I probably had no job (but I had); that no engineer deserving the name would so lower himself as to do window washing and floor washing (I never said they would, but I have often washed the engine-room floor and windows and felt as high up as ever); that if a man were hired as an engineer, that is what he should be; etc.

I imagine many of these fellows who shout so loudly when a little extra work is required, and talk so much about the dignity of engineers, hardly know what the meaning of the term is. A man who will do nothing outside of running an engine is not an engineer, he is simply an engine runner, or what a genuine engineer would call a "starter and stopper."

In a plant where there are a number of different machines nobody would expect a man to do anything outside of the regular engine-room work, but in the "one-horse affairs" I say he should do anything possible when it will not take him away from the engine room, or interfere with the proper running of the plant. In my present position I have four men under me, with additional men to bring in coal and take away the ashes, and I am not ashamed to say that I am continually doing some work which I think should be done, but which I need not do. I could get out of many a job and "take it easy," but I fail to see what I would gain either in dignity or "coin." My men are expected to keep all apparatus in their charge clean and in repair, and I see that they do it. Neither myself nor either of my men is overworked, but we do not spend two-thirds of the day holding down chairs when there is work to do.

JAMES E. NOBLE.

Toronto, Can.

## A Case of Boiler Corrosion

A peculiar case of corrosion is described in the following: Feed-water entered a boiler through a 2-inch pipe

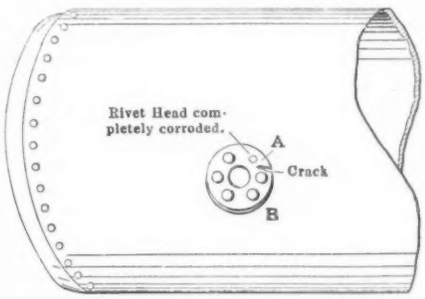



FIG. 1. WHERE THE LEAK DEVELOPED

screwed into a flange riveted to the boiler as shown at *B*, Fig. 1. A leak developed between the flange and the boiler shell at *A*. The brickwork was cut away and an attempt made to calk the joint, when it was discovered that the boiler shell was very thin. A piece of the boiler shell, the

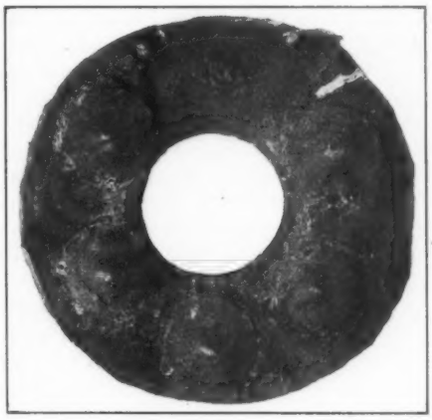


FIG. 2. SHOWING THE CORROSION

same size as the flange, was cut out with the flange attached to it; one of the rivets, besides part of the plate, was badly corroded, as shown by Fig. 2.

Doubtless the constant upward movement of the entering water was responsible for the trouble. It is a practical lesson, as it proves that any pipe constantly carrying fluid into a boiler, or tank, should extend some distance inside when the inlet is on the side or end. It is advisable to carry a feed-pipe quite a distance inside a steam boiler in all possible cases, and the side is a poor place for a feed-pipe to enter.

JAMES E. NOBLE.

Toronto, Can.

## An Expensive Layout

A few years ago I was employed in a shop that contained the greatest mixture of good and bad features I ever saw.

The president of the concern was professor of mechanical engineering in one of the big universities. He had planned the layout of the shop and had put in operation all of his pet theories and then some. If his theories had been in accordance, even to a small degree, with conditions found in actual practice he would indeed have had a model factory.

A few of the good features were: The building was placed high and dry; it was long, wide, and well lighted, both from the sides and from the skylights; the line shafting was well placed, and the traveling-crane system was fine.

There the good points ceased. The machines were placed with no thought whatever as to the way work was to travel, with the result that when one operation had been performed the chances were that the piece had to be taken to the other end of the shop for the next operation, and then back again to within a few feet of where it started.

The line of steam pipe that fed the heaters ran for about 125 feet along one side of the shop in a trench about 2 feet deep and 18 inches wide. Feeders were run from this to radiators placed at intervals on each side of the shop, which was about 40 feet wide. These feeders were also in trenches, similarly to the main line.

Had the system been so that it would operate without leaks it wouldn't have been so bad, but it leaked at every joint when steam was turned into it. The line had been laid in the spring and not used until fall, and in the meantime everything in the shop had been installed, so that when the leakage showed about 40 feet of benches had to be torn up, a punch press and a boring mill moved, and the entire series of cupboards and shelving in the tool room torn away. This applied to the main line only, and the feeders all came in for their share of trouble.

There wasn't a gasket used, but instead a kind of putty, which looked like a mixture of oil, graphite and portland cement. I learned afterward that this was a secret mixture of the professor's, and was expected partially to harden into a "rubbery" mass.

The pipe threads had been treated to a coat of what must have been cylinder oil, no lead being in evidence.

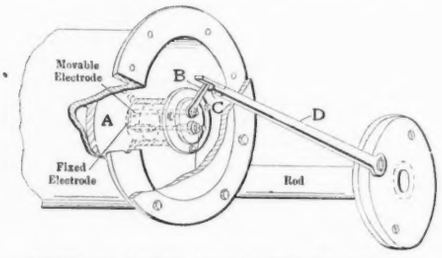
It seems absolutely unbelievable that such work would be done. As one of the men expressed it: "It was just what the doctor ordered."

ETHAN VIALL.

Decatur, Ill.

## One of those "Mysterious" Gas Engine Troubles

For a long time this engine ran nicely, giving little or no trouble. But finally came a morning when after a few "coughs" it slowed down and then stopped. Examination and trial of the ignition system showed no spark. As one of the electrodes was worn down into the metal that held it, a new one was put




SHOWING CAUSE OF GAS-ENGINE TROUBLE

in, after which snapping the igniter by hand showed a very good spark but efforts to start the engine resulted in failure. Not a single explosion could be obtained. After several removals of the igniter, the spark always being good when tried outside of the cylinder, it was decided that the trouble was elsewhere and a complete examination of the engine and its accessories was made, but everything seemed all right. Hours were spent in searching for the trouble and several men thought to know something of gas engines were called in, but all of them were stumped. Finally one man came in who had worked on a similar engine and had seen what he thought was the same trouble before, and a few simple measurements showed him that he had located the trouble. "I can make her run," he said, and then he put in a few seconds of work with a file, dressing off considerable of the contact point of the new igniter electrode. The new electrode point *A* in the accompanying sketch had been left too long, causing the outer end *B* of the electrode lever to catch on the shoulder *C* of the tripping end of the push-rod *D* instead of the extreme end of the trip finger. Filing off this electrode point allowed the finger to engage the electrode arm properly and operate the igniter.

The engine was started up and ran nicely for a few minutes and then again stopped. Removal of the igniter showed oil on the points of the electrodes. An oil cup that fed oil to the cylinder had been given a liberal feed rate to assist the men who had been doing the hard work of turning the fly-wheels over, and it was supposed that this caused the present trouble. So the oil feed was cut down, the superfluous oil wiped out, the electrodes cleaned and another trial made. The result was the same—several ignitions and then another stop. The man who had fixed the electrode began to think that he didn't know so very much, after all, and it was only after a lot more time and work had been wasted that the cause of the first stop was discovered. The main and crank-pin bearings and outer end of the piston were lubricated by means of the splash system, and it was found out that just before the first trouble occurred the oil basin in the crank case had been filled too full, causing the oil to work back past the piston to such an extent as to prevent operation.

ROYAL WOLFE.

Lancaster, O.

## Power Plants for Sawmills

I read with much interest the article under the above heading in the issue of June 23, and fully agree with the writer in his conclusions. I think, however, that he has not brought out one point sufficiently strong, and that is the "pulling power" of the two types of engine, steam and gas, for this kind of service. As is well known, the steam engine will develop from 100 to 200 per cent. more power than its actual rating, for short periods, with perfect safety, and thousands of engines are doing it daily. On the other hand, the gas engine is usually sold on a horsepower rating as high as possible, and if it has a 15 per cent. margin it is fortunate, but unusual. Then again, the quality of the gas may easily vary so much as to decrease the available power from 10 to 15 per cent.; a still further limitation.

It will thus be seen that a sawmill must be equipped with sufficient power to carry its peak load. If this is 500 horsepower, with an average load of 250 horsepower, that is, a "load factor" of 50, the steam plant could be of nominal 250 horsepower size, but the gas plant must be 500 horsepower. As the gas plant costs from 25 to 50 per cent. more than a first-class steam plant, and assuming depreciation, labor costs, water, etc., about the same, the interest charge would, therefore, place a heavy handicap on the gas project.

There are plenty of plants where gas power is not only worth considering but would seem to have a decided superiority. As Mr. Blackmur points out, more considerations than thermal efficiencies come into the problem of powering a mill.

After the power question is decided, that of distribution is next in order, and here again your author has covered the question well. A recent occurrence in a textile mill brings another element into the electric-drive problem which is not ordinarily considered. This mill is equipped with motors driven from a central power plant, and during a thunderstorm two of the large motors were burned out and all of them had electric discharges. None of the fuses was blown. The protection from lightning is a serious matter in mills where lint or cotton has accumulated and is inflammable, but it may be perfectly possible to protect the mills from this danger.

M. EMERSON.

Boston, Mass.

## Is Not Perpetual Motion

The letter by O. A. Benkendorf in the June 23 number, pertaining to a perpetual-motion device, set me to figuring, and the following is the result:

Consider a ring with outside and inside radii $r$ and $r_1$, respectively (see illustration). Let $OP$ be perpendicular from the center $O$. The moment of a thin horizontal layer at any distance as $X$ above or below the center is

$$\frac{n+n_1}{2} \times n - n_1 \times \textit{thickness},$$

$n$ and $n_1$ being respectively the horizontal distances from $OP$ to the outside and inside of the ring,

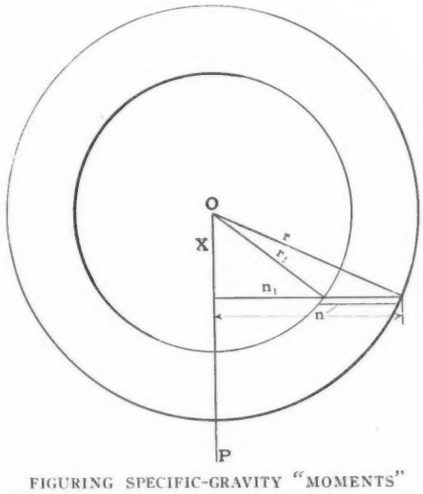
$$n = \sqrt{r^2 - X^2},$$

$$n_1 = \sqrt{r_1^2 - X^2},$$

$$\frac{n+n_1}{2}(n-n_1) = \frac{n^2 - n_1^2}{2}$$

$$= \frac{(r^2 - X^2) - (r_1^2 - X^2)}{2}$$

$$= \frac{r^2 - r_1^2}{2}.$$




FIGURING SPECIFIC-GRAVITY "MOMENTS"

That is, for layers of a given liquid and of equal thickness, the moment is constant, since $r$ and $r_1$ are both constant, without respect to differences in $X$; and hence in $n - n_1$ and the mass of the layer. Therefore, the moments of layers of different specific gravities will vary as the product of their respective thicknesses and specific gravities.

Since mercury has a specific gravity of 13.58, the sum of the thicknesses of all the layers of mercury in one side is $\frac{1}{13.58}$

of the hight of the water on the other, and the moment of one equals the moment of the other. When the liquids are allowed to take their respective hights there will be no tendency to rotate.

S. FARIS.

Milwaukee, Wis.

## Lightning Protection for Tall Chimneys

I was very much interested in the article on "Lightning Protection for Tall Chimneys," by A. Rauch, on page 102 of the July 21 issue. There are a number of points mentioned in this article which are not quite clear. For instance, it is well known that by introducing a sharp turn in a lightning conductor a very serious choking effect is produced on the flow of the current to the ground, so much so as to sometimes cause the current to leave the conductor and travel down the object to be protected. From the information given, two short-radius 90 degree bends are made at the top of the stack. This would undoubtedly result in the destruction of the upper part of the stack, at least before a reasonably low inductive path to the ground was provided by the straight run of cable.

I am at a loss to understand just what function the sharp platinum tip is to perform. With a lightning discharge such as I have seen melt porcelain fittings so they ran down a wall like icicles, it would seem that even platinum would not last long.

As to the size of the cable, I do not consider that nearly so important as are the number of cables and the distance they are apart. In dealing with a lightning discharge, we have a very high frequency current to contend with, and it is necessary to comply with some rather important details.

With currents of this kind, practically speaking, a 2-inch copper rain conductor is as good as if it were solid copper, so far as current-carrying capacity is concerned. I have seen a "harp" made of ten No. 18 bare-copper wires, spaced 2 inches apart, carry the same current which very seriously heated a copper rod 1 inch in diameter. I have seen a large heavy brass clamp, about the size of a man's hand, attached to a 3/8-inch copper tube, and the same current which the tube carried easily heated the brass clamp to the sizzling point, and a ½-inch iron pin in the center of the clamp was brought up to a dull, cherry red.

This, of course, was not owing to any question of resistance, but it shows that some apparently minor details may turn out to be important ones if not properly taken into account. I would like to know what protection the ordinary lightning rod affords, when fastened to a house on top of a glass insulator with an iron clamp completely surrounding the conductor.

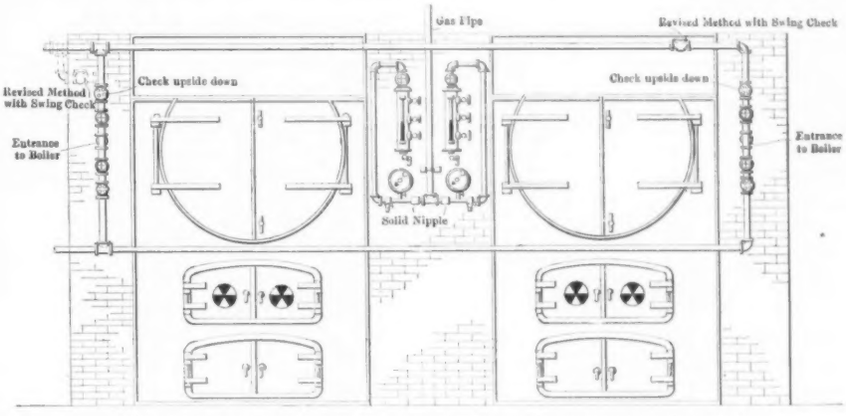
Copper ribbon is preferable to cable, even if joints are necessary, as resistance is not paramount. By all means avoid iron, as rivets, clamps, anchor bolts, etc., should be of copper or brass.

H. R. HADFIELD.

Newark, O.

## A Steam Plant Repair

Nearly every engineer has his own particular method of making repairs which, of course, he thinks is the only one. I recently came across a case of this kind in a small factory, the engineer of which was a new man, who was naturally anxious to make as good a showing as possible. Among other jobs put upon him was the remodeling of the heating system. In the old system live steam was used and the return drips went through a trap over the boilers. As this trap was very badly worn it gave considerable trouble, and was also the cause of much complaint about the lack of heat in the factory.




SHOWING OLD AND REVISED METHODS OF RETURNING THE DRIPS

It was finally decided to adopt a new method of return, so a duplex pump and receiver were purchased.

When the new receiver was installed the discharge line from the receiver pump was connected into the feed line. This method worked well until it was attempted to feed the boilers, which was done by the use of an exhaust injector. This injector worked splendidly until the receiver pump began to operate. It was then found that the pulsation of the receiver pump, which discharged into the same pipe or feed line, caused the exhaust injector to "break." A separate discharge line was installed from the receiver and the piping on the boilers changed, the feed-water pipe being carried across the boiler fronts above the fire doors and the return pipe from the receiver carried across at the top of the fronts, as shown in the illustration.

A tee was put on the feed pipe where it entered the boiler, with the idea of carrying the discharge of both lines into the boiler by the same opening. A vertical check valve and a globe valve were placed in the feed line, as shown, and a globe valve and a vertical check valve on the return. Here they made a unique change regarding the check valve, which was placed upside down, with the idea of having the boiler pressure on the upper side of the seat. This scheme worked all right as long as a steady pressure was maintained to hold the seat of the check valve in position, but as soon as the receiver pump commenced to discharge there was trouble, for as soon as the check valve was forced away from the seat it admitted boiler pressure to both sides of the valve, and as the check valve was installed upside down the weight, in addition to the pressure on the upper side, caused the valve to fall away from the seat, thus rendering it inoperative. If there had been but one boiler, the installation of a horizontal swing check valve in the line would have solved the problem, but as there were two boilers, and as it was imperative that the piping be arranged so that the return might be fed to either boiler, two check valves were necessary in order to prevent priming from one boiler to the other, as would be the case if one boiler should be forced a little more than the other.

A horizontal swing check valve was placed at the No. 2 boiler and in order to obtain the same result at No. 1 boiler, a tee was inserted in the line and a drop of 6 inches allowed. Then an ell and a piece of pipe were run parallel with the main return pipe, connecting with the swing check valve, as shown. After this change had been made the arrangement worked finely, and it made a neat-looking job.

CHARLES H. TAYLOR.

Bridgeport, Conn.

The ordinary method of taking the temperature of a coal pile, by lowering a thermometer down pipes scattered through the pile, is not satisfactory, as the heat of such piles is irregular, and the location of greatest heat may be missed altogether.

# The First American Steam Turbine

## The "Bailey Jack," Patented by a New Englander More Than One Hundred Years Ago, Now in Possession of the Inventor's Granddaughter

BY F. E. DRAKE

Examination of the records of the United States Patent Office shows that early in the history of the country some of the possibilities of the use of steam as a motive power were recognized to a great extent, and men from many walks in life were engaged in designing machines intended to transmit the power of steam into motion that could be made to do useful work.

The first steam patent in this country bore the date of August 26, 1791, and was issued to James Rumsay, "for improvement of Savary's steam engine." On the same date a patent was issued to John Fitch, "for propelling boats by steam;" one to Nathan Reed, "for an improved steam boiler;" three to John Stevens—later inventor of the screw propeller—two of which were for improvements in boilers and engines and one for "apparatus of steam to work bellows." On the same day, E. Cruse received a patent for an improvement to a steam boiler.

John Bailey's name is 39 on the list of United States patents, and ninth in the list of patents for apparatus involving the use of steam.

Seven of these patents issued to the persons here named dealt with the great problem of steam navigation; one only with the application of steam to a minor mechanical device, namely, John Stevens' steam bellows.

This shows that John Bailey's "jack" was the second article operated by steam, aside from a steam engine, for which a patent was issued in this country.

The patent and the original cast-iron machine for which it was issued are owned by Mr. Bailey's granddaughter, Miss Catherine Bailey, of Chancery court, Lynn, Mass. Miss Bailey shows the original patent with great pride. It is on sheepskin parchment. The writing, in a clear hand, is still legible. The signature of Washington is faded.

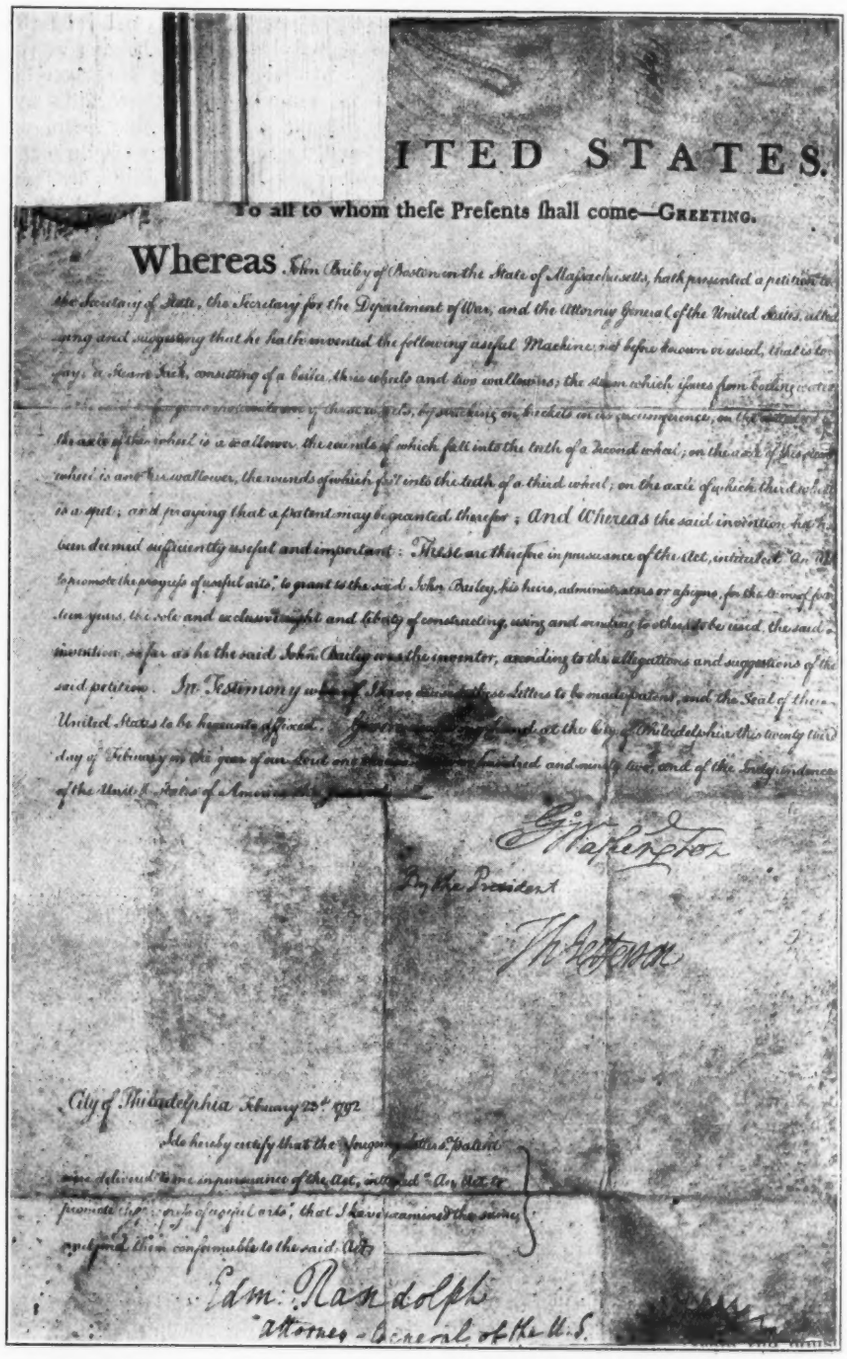
A rectangular piece has been cut out of the upper left-hand corner of the parchment.

"An autograph collector did that," said Miss Bailey. "The autograph of Thomas Jefferson was on the back, and he cut that piece out to get it. There were two autographs of Jefferson on the document. The other remains."

The patent (Fig. 1) reads as follows:

THE UNITED STATES

WHEREAS John Bailey, of Boston, in the State of Massachusetts, hath presented a petition to the Secretary of State, the Secretary for the Department of War, and the Attorney General of the United States, alledging and suggesting that he hath invented the following useful machine, not before known or used, that is to say, a Steam Jack, consisting of a boiler, three wheels and two wallowers; the steam which issues from boiling water in the said boiler gives motion to one of those


ITED STATES.

To all to whom these Presents shall come—GREETING.

Whereas John Bailey of Boston in the State of Massachusetts, hath presented a petition to the Secretary of State, the Secretary for the Department of War, and the Attorney General of the United States, alledging and suggesting that he hath invented the following useful Machine not before known or used, that is to say, a Steam Jack, consisting of a boiler, three wheels and two wallowers; the steam which issues from boiling water [illegible] the axle of the wheel is a wallower, the rounds of which fall into the teeth of a second wheel; on the axle of this second wheel is another wallower, the rounds of which fall into the teeth of a third wheel; on the axle of which third wheel is a spit; and praying that a patent may be granted therefor; And Whereas the said invention hath been deemed sufficiently useful and important: These are therefore in pursuance of the Act, intituled "An Act to promote the progress of useful arts," to grant to the said John Bailey, his heirs, administrators or assigns, for the term of fourteen years, the sole and exclusive right and liberty of constructing, using and vending to others to be used, the said invention, so far as he the said John Bailey is the inventor, according to the allegations and suggestions of the said petition. In Testimony whereof I have caused these Letters to be made Patent, and the Seal of the United States to be hereunto affixed. Given under my hand at the City of Philadelphia this twenty third day of February in the year of our Lord one thousand seven hundred and ninety five, and of the Independence of the United States of America the [illegible]

G. Washington

By the President

Th. Jefferson

City of Philadelphia Febuary 25th 1792

I do hereby certify that the foregoing Letters Patent were delivered to me in pursuance of the Act, intituled "An Act to promote the progress of useful arts," that I have examined the same, and find them conformable to the said Act.

Edm: Randolph

Attorney General of the U.S.

FIG. 1. FAC-SIMILE OF PATENT FOR THE "BAILEY JACK"

wheels, by striking on buckets in its circumference; on the outer end of the axle of this wheel is a wallower, the rounds of which fall into the teeth of a second wheel; on the axle of this second wheel is another wallower, the rounds of which fall into teeth of a third wheel; on the axle of which third wheel is a spit; and praying that a patent may be granted therefor; AND WHEREAS the said invention hath been deemed sufficiently useful and important: These are therefore in pursuance of the act, entitled "An act to promote the progress of useful arts," to grant to the said John Bailey, his heirs, administrators or assigns, for the term of 14 years, the sole and exclusive right and liberty of constructing, using, and vending to others to be used, the said invention, so far as the said John Bailey was the inventor, according to the allegations and suggestions of the said petition.

In testimony whereof I have caused these letters to be made patent, and the seal of the United States to be hereunto affixed. Given under my hand at the city of Philadelphia this twenty-third day of February, in the year of our Lord one thousand seven hundred and ninety-two; and of the Independence of the United States of America the sixteenth.

GEO. WASHINGTON.

By the President.

THOMAS JEFFERSON.

City of Philadelphia, February 23d, 1792—I do hereby certify that the foregoing letters Patent were delivered to me in pursuance of an act, entitled "An act to promote the progress of useful arts," that I have examined the same, and find them conformable to the said act.

EDMUND RANDOLPH,
Attorney General of the United States.

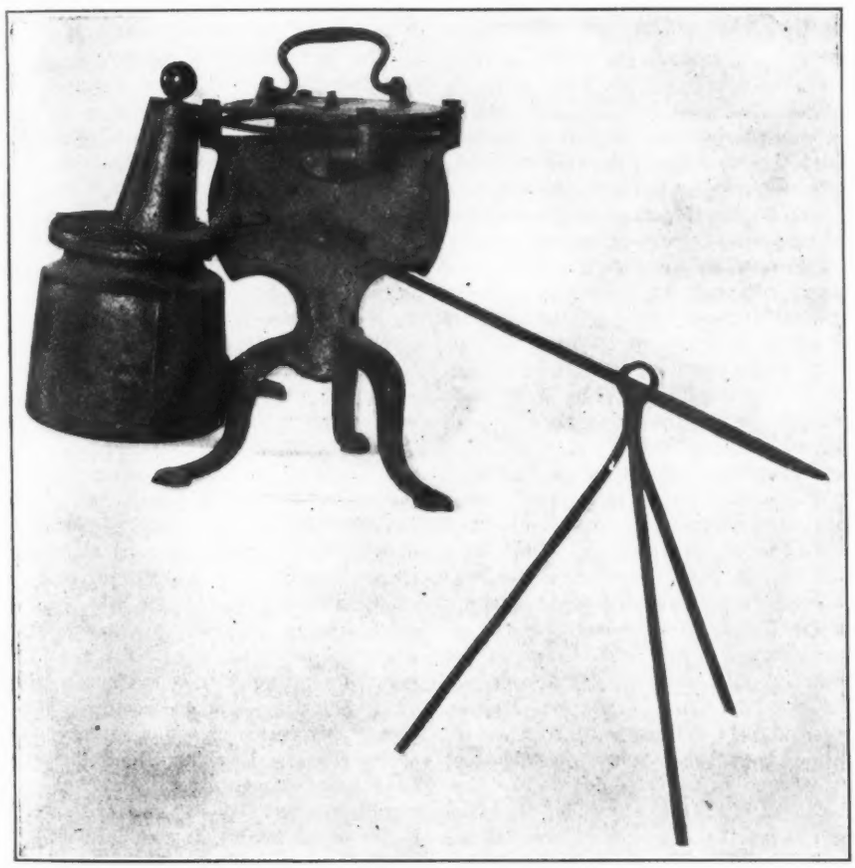


FIG. 2. THE "BAILEY JACK"

## THE "BAILEY JACK"

In 1792, Mr. Bailey took out a patent on the "Bailey turbine," or as he called it, the "Bailey jack." The "Bailey jack" is is a boiler and turbine combined and was invented for roasting fowls in the large open fireplaces they had in his time. The apparatus stands about 14 inches high and is of solid construction, weighing in all about twenty-five pounds. The boiler, the casing for the gears and the plate above the bucket wheel are made of cast iron and are supported by three cast-iron legs which form part of the gear casing. The boiler is riveted to this casing.

The bucket wheel is about 7½ inches in diameter and about ¼ inch thick, made of wrought-iron plate. The buckets are ratchet teeth cut into the wheel, as shown in Figs. 2 and 3.

Through the center of the bucket wheel is a steel shaft about ⅛ inch in diameter.

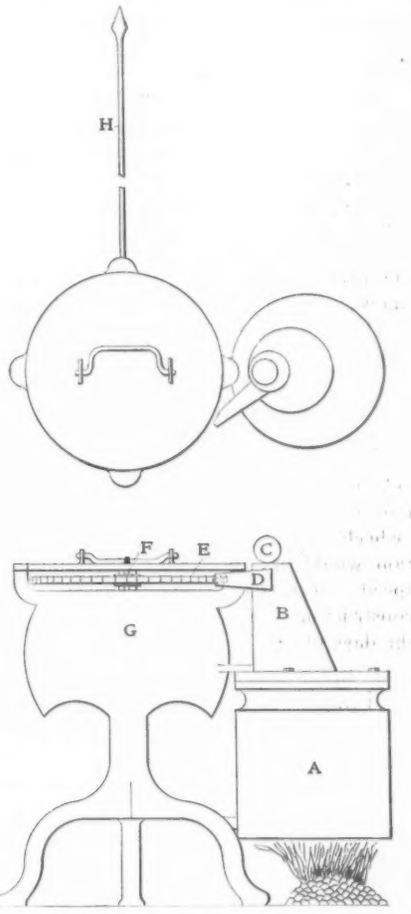



FIG. 3. PLAN AND ELEVATION OF THE "BAILEY JACK"

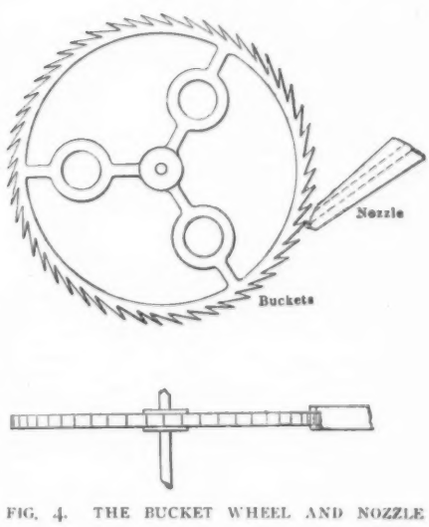



FIG. 4. THE BUCKET WHEEL AND NOZZLE

The shaft has needle-point bearings, both top and bottom, very much like the pivot wheel of a watch. On the lower part of the shaft and inclosed in the casing is a system of worm gearing, or, as designated in the patent, "wheels and wallowers."

These gears operate the arm or spit upon which birds were strung to be roasted. This arm made a revolution every two minutes. The bearings of the shaft are so fine and the entire mechanism is so accurately made and nicely balanced that even today (116 years from the date of the making) the turbine will revolve for several minutes when set in motion by a slight tap of the finger.

On the top of the boiler is a round ball which answers the double purpose of a safety valve and stopper for the hole through which the boiler is filled.

In Fig. 3 are shown the boiler *A*, the steam space *B*, the safety valve *C*, the nozzle *D*, the bucket wheel *E*, the shaft *F*, the gear casing *G* and the spit *H*. Fig. 4 shows in detail the buckets and nozzle.

The turbine and letter of patent, Miss Bailey says, are to go to the Massachusetts Historical Society when she is through with them.

It is much to be regretted that the present owner of the jack would upon no consideration allow the opening up of the interior gears of the machine to show the "wheels and wallowers," as an examination would have revealed the manner of speed reduction and possibly a method of constructing worm gearing long before the days of the milling machine.

## Trade Opportunities in Peru

By M. de Moreira

Peru, although not as large as either Brazil or Argentina, offers, nevertheless, great opportunities to American manufacturers and still greater ones to American capitalists. Financially speaking, Peru obtained a splendid result for 1907, inasmuch as her revenues were increased and her expenditures reduced. The receipts amounted to $13,396,330, and the expenditures to $10,535,205.

Following are a few items which will show that Peru's prosperity is built on a serious basis: The revenues derived from the taxes administered by the national company of collections amounted in six months to $2,075,000; the interest on the national debt, amounting to $13,300,000, has been paid to date; the claim of the guano company of the United States has been paid by an issue of $7,385,000 in bonds of the public debt. The report of the Peruvian corporation whose operations for 1907 show a profit of $1,000,000 is another proof of the prosperous conditions of business in the republic.

Before going into details regarding the opportunities within the reach of the manufacturers, I will say a few words regarding the great possibilities for capitalists.

Iquitos, the shipping center of eastern Peru, which imported last year from the United States $3,148,713 worth of merchandise, has no sanitary drainage, no telephone system, and only a small narrow-gage railroad inadequate for the needs of the town. In view of this, it seems to me that a syndicate of capitalists would reap a golden harvest if it would undertake the drainage of the town, the installation of a telephone system, and of an electric-light plant. The Peruvian government, I am sure, would grant valuable concessions to anyone planning this work, and the results would certainly not be small.

Statistics show that American manufacturers have exported proportionally more to Peru than to any other South American republic. The products exported by the United States in 1907 amounted to $6,876,217, composed mostly of railroad materials and supplies, agricultural implements and general merchandise.

### Railroad Opportunities

The Peruvian government is making every effort to increase the railroad facilities of the country and has thus far made Peru a good buyer of railroad materials and supplies. Peru has now eight organized lines, all having their car and repair shops. Although Peru buys her cars in the United States, many of the old cars are rebuilt in Peru, necessitating machine tools, bought until now mostly in England. Another line is being built from Cuzco to Santa Anna, and goes through the provinces of Colca and Urubamba. The Peruvian corporation of London, which operates the state railways under lease, is carrying out the prolongation and extensions of several lines. One other line, of the most importance for our manufacturers, is planned to the Amazon via the Ucayali river. This line will require a large quantity of steel rails, rolling stock and other materials. The construction was to have begun in August, 1908, and to be finished in 1913. The concession which the Peruvian government has granted is for a standard-gage line, which will start near Oroya on the existing railway, and end at a point on the Ucayali river. It will be suitable for steam navigation all the year around for vessels of at least 5 feet draft. A subsidy of about $10,000,000 is provided in 6 per cent. bonds at par value, to be delivered in half-yearly instalments and in proportion to the number of kilometers finished in the same period. A grant of 7500 acres of land is made for each steamer of 500 tons. Shops are all ready at the Ucayali end to handle the requisite works; and as far as I can learn, the shops alone are ready, that is to say, the machine tools are not yet installed and only few have been purchased. Isn't this a good opportunity for the American manufacturer to sell his goods to that railroad company?

The maritime movement of the republic is not as progressing; however, a new line of steamers, between Callao and New York, via Panama, is expected to be in full operation this year. Fast steamers are now under construction and the company's intention is to make the run from Panama to Callao in five days instead of the long trip of 13 days required now. That company has also under contract the building of a dry dock in the port of Callao.

### Mining-machinery Opportunities

The wealth of Peru is naturally in its mines. Here are the last statistics obtainable on their value (1906): Copper, $4,980,275; silver, $4,864,790; petroleum, $1,212,710; gold, $851,775.

In 1907 the Cerro de Pasco mine shipped to the United States 10,000 tons of copper of the 28,000 tons reported shipped by the whole of South America. The famous gold mine, Santo Domingo, of the Inca Mining Company covers 90 working claims and about 63 are now being operated.

As water is abundant, the large mining companies are planning to establish an electrical smelting plant. The Cerro de Pasco Company has made extensive investigations of the power which may be obtained in the regions adjacent to its properties, and the results are said to be very favorable. Within 36 miles of the smelter available 15,000 horsepower has been located, and at a distance of 55 miles and an elevation of 10,000 feet they can obtain 25,000 horsepower.

Near Lima on the Central railway, at a place named Rio Blanco, where Americans have a smelting plant and where 3000 horsepower is available, machinery is being installed for that purpose. Other electric installations are in prospect in the department of Ancacho, which is the chief mining province of the country. Electrical power is used in a very few towns for tramway transportation.

Though there is a prospective application of electricity on a large scale, such as for mines and smelters, there seems to be a more immediate demand for light manufacturing. About 2000 horsepower in five power circuits is now furnished by the trust to the mills and factories of different kinds in Lima and vicinity.

As one will see, there are many opportunities for the machinery and machine-tool manufacturers. Bank facilities, however, are not very convenient. This could be easily arranged, as there are enough American houses in Peru or houses doing a large business with the United States which would, for a regular banking commission, look after the interests of the manufacturers. There is one thing, however, which the American manufacturer must beware of and that is the New York commission house, through which a great part of his goods are sold. The commission they charge (the real commission, I mean, not the apparent one) is so high that added to the excessive freight rate it often renders the price of American products prohibitive.

# Diversified Uses of the Centrifugal Pump

## Adaptation to Boiler Feeding, Dry Dock and Sewage Pumping; Pumps for General Industrial Purposes; Tendencies of Future Development

BY E. F. DOTY

### Boiler-feed Pumps

There are some few builders who are entering this field and who are prepared to recommend and install multistage turbine pumps for feeding boilers. These are usually direct-connected to electric motors or steam turbines. It is not the intention to question the judgment of these builders, nor their ability to produce a pump satisfactory for this purpose, so long as the steam-pressure regulators remain in perfect working order. It will be appreciated, however, that regulators that are automatic do not always regulate, that safety valves sometimes stick and that low water in boilers may have fatal results.

A centrifugal pump of any type, running at constant speed, will operate against a constant pressure, and at this constant speed the difference in the pressures against which it will deliver water at rated capacity, and its failure to deliver any water at all but simply to work against a pressure due to its speed, is comparatively small, say 10 pounds per square inch. Suppose a boiler to be working at 160 pounds pressure and a turbine boiler-feed pump jogging along and feeding freely at this pressure; suddenly the pressure raises 10 or 12 pounds and unless the fireman speeds up the feed-pump it will deliver no water against the increased pressure.

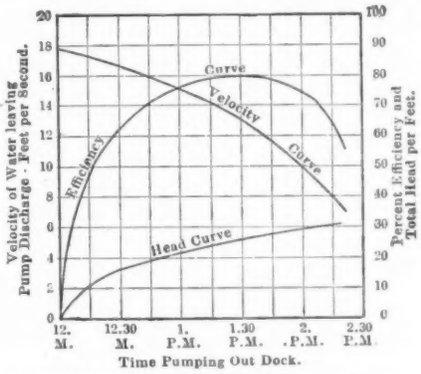
If the pump driver will allow of speed variation and a close watch is kept on the water column, all may be well, but it would seem that there is an increased chance for serious accident due to this peculiarity of these particular pumps. It would be gratifying indeed to have this all satisfactorily explained away and to become convinced that the fears expressed are groundless, because it would appear that other than for the exception taken, these pumps are well adapted for boiler-feed service.

### Dry-dock Pumps

In this service the conditions met with are entirely different from almost any other kind of pumping, the object being to empty the dock in the least possible time consistent with the proper landing of the ship to be docked. One of the features in this service is that the sectional area of the dock decreases as the lift increases; so that much less water is contained at the lower levels.

There are two distinct types of dry-dock, the pumpage from which requires rather different treatment The first is known as the graving-dock, or a dry-dock which is permanently located and where the ship is lowered onto the keel blocks as the pumps lower the water within the dock. With this type the pumping plant is usually located in a chamber on shore and adjacent to the seaboard end of the dock, so that the suction and discharge pipes may be kept as short as possible.

The second is the floating dry-dock, either in one large portion or in sections. As its name implies, this dock is afloat, and when it is desired to raise a vessel the dock is submerged by admitting water to the inside of the dock to a depth which permits the vessel to be floated over the main floor of the dock. The pumps are then set to work to discharge the water




VARIATIONS OF HEAD VELOCITY AND EFFICIENCY

from the dock, and allow it to raise the vessel by means of its buoyancy. In floating dry-docks the pumps are necessarily placed within the dock itself and are located at the outer sections within the upright caissons of the U-shaped section comprising the dock.

The centrifugal pump has been all but universally accepted as the best type for dry-dock service, and this has long been the case. Their adaptability for handling large volumes at low heads, low first cost and the fact that they do not deteriorate rapidly when left unused for a time, are the chief points in their favor. Steam engines and electric motors are the usual methods of driving, the latter of late years almost entirely superseding the steam-driven pumps. The reasons for this are very evident, for at nearly every large dock-yard there is now provided a central electric-generating plant of considerable capacity, and current from this station can be readily directed to the dry-dock motors when it is desired to empty the dock, which consumes usually from 1 to 3 hours. It is then evident that it is not necessary to maintain a large steam-generating plant adjacent to the pump house, and where an electric-generating plant is not among the attributes of the dock-yard, current can usually be purchased at advantageous prices.

With floating dry-docks electric current may be used to advantage where there is a supply available and the dock is permanently attached to any point of location, but otherwise steam-engine-driven pumps are the rule. In any case the pumps are of the vertical-shaft type and the engines either bevel-geared or of the vertical-shaft construction themselves. Such motors as are used for this service are vertical-shaft machines. With steam-driven pumps the engines and boilers are located at the top of the side caissons, so that they are always above water when the dock body is submerged.

For reasons already given in this article covering the objects in view of quickly emptying the dock, the pumps, with zero head at the start, are customarily put to work at full speed or nearly so and are kept steadily working at this speed throughout the operation. In graving-docks the increase in lift and decrease in capacity at constant speed bear a gradually changing relation to each other throughout, and this is so to a certain extent with the floating dock While the performance goes on, the pumping conditions change somewhat, as the upper surface of the main floor is uncovered and the weight of the ship is taken by the dock. The side sections being comparatively small and of little lifting power are quickly emptied. The lift is always the difference in level of the water within the dock and without, so that the curve for lift would show an increasing lift from the start up to the time the floor was uncovered, then a rather sudden reduction of lift, which would again gradually increase until the pumps finished their work.

It will then be evident that when dealing with these variable heads at constant speed, the designer has before him, in the first place, a study of the contents or volume of the dock and he is particularly interested in its cross-section and relation to prevailing outside water levels. He must then fix upon the mean head and capacity which will give sufficient speed to deliver water at maximum head and at the same time will not seriously overload

the motor at zero head. In the accompanying curves is shown a characteristic of such a pump handling large volumes of water, and considering the range of work, it will be seen that the efficiency is very well maintained throughout.

### Sewage Pumping

As with dry-dock pumps so with sewage pumping, the conditions usually favor the centrifugal type. The heads are usually quite low and the volumes large. The decided advantage here, in addition to those of a general character to all service, is the absence of valves and the free, easy passages throughout the entire pump which permits of handling raw or rough-screened sewage without choking up the pump. There are notable examples of pumping plants handling large volumes of sewage at great economy in such cities as Chicago, Boston, New Orleans and others, where the selections are made of the very best, all things considered, and by engineers who are acknowledged authorities.

Durability and maintained efficiency are always apparent in centrifugal pumps, and nowhere more so than in handling sewage, where the acids will corrode and entirely eat away the interiors of pumps of any other type, even though protected by bronze fittings at the points of greatest attack.

For a long time the sewage pumps at Boston, built by the E. P. Allis Company, Milwaukee, Wis., held the record for centrifugal pumps driven by steam engines, for the best duty from coal. This duty was in excess of 90 million foot-pounds of work per 100 pounds of coal burned, and it was maintained fairly close throughout the year's work. This duty has since, however, been exceeded with pumps driven by compound high-speed engines, and as the Boston pumps are driven by triple-expansion Corliss engines, it will be evident that the improvement has come through the pump or water end of the combination.

### Pumps for General Industrial Purposes

There are many fields in which centrifugal pumps are giving excellent results and are in high favor, but within the scope of this article it will be impossible to enumerate in detail. Drainage and filtration works, paper mills, dye houses, for tank service as boosters to the regular domestic pressure, circulating brine in refrigerating and ice-making establishments and innumerable other places require the services of centrifugal pumps.

Many of these places permit the use of pumps of a standardized character, while others require special construction of details to insure the best results, and right here let it be said to users of pumps, do not be afraid to particularize fully when sending inquiries to the manufacturer for new pumps. Better service will be secured if the manufacturer understands the minute requirements of the work. Half the troubles ascribable to pumps not doing satisfactory work may be attributed to a lack of information on the part of the builder as to the actual needs of the user. The builder, perhaps, does not care to bother his customer unduly about furnishing details, but it were better that these matters were understood in the first place than to lead to unpleasant relations in the end.

### Priming

The centrifugal pump is not a machine which will pick up water of its own accord until a vacuum is formed and the air expelled from the pump casing. This statement is absolute, even if the suction lift is the shortest possible distance. In some instances the pump will be so installed that its casing will fill by gravity from some source of supply, in which case this is the best arrangement that can possibly be made for priming.

Where steam is available, the steam ejector or exhauster attached to the highest point of the pump casing is a satisfactory apparatus for exhausting the air from the pump, and when steam cannot be obtained, air or water under pressure may be substituted. Care should be exercised to obtain an ejector with a nozzle designed for the particular source of velocity and pressure available. Another excellent method is to attach the highest point of the casing to an air pump; in some large centrifugal installations a small air pump is provided especially for this purpose and is connected with all of the centrifugal pumps.

When the pump is primed from a source of water supply which does not enter through the suction pipe or submerge the pump, a foot-valve should be provided to prevent the water from running away through the suction pipe. A gate or check valve (in some cases both are desirable) should be placed in the discharge line as near to the pump as possible.

Whenever it can be so arranged the pump should be kept idle until the priming is completed, especially when an ejector is used; the discharge valve should be closed tight. The reason for not running the pump during the priming operation is that the impeller stirs up a vapor when the pump is partially filled with water, and in consequence it is rather difficult to separate and expel the air, it takes longer to prime the pump, and there is greater chance of the formation of a pocket of air at the top of the casing which would prevent the pump starting to work properly. When primed, start up the pump before opening the discharge valve, if a gate, and when nearly up to speed open the valve gradually.

### Pump Control

The centrifugal pump being essentially a one-speed machine, will operate at maximum efficiency only at one condition of speed, discharge and lift. Control may be effected by throttling, speed variation, or by both. Theoretically, throttling should be applied only in the discharge pipe. Speed control alone cannot usually be applied satisfactorily, due to the fact that the lift varies as the square of the speed, and the discharge directly as the speed. There is but one service that meets these inherent characteristics exactly, viz., where the pump is used to circulate a fluid, such as a circulating system for oil, or for surface condensers. The head here is largely friction and varies as the square of the velocity of flow, and this varies directly with the discharge. Hence the pump can be controlled by speed variation alone very efficiently.

In cases of this kind the pumps may be driven by direct-current shunt motors and speed variation obtained by shunt-field control. The combined unit will be quite efficient. The motor, however, will be large, as it must give continuous operation at high speed at its normal output. All speed variation in such service will have to be below normal, as with long piping systems, such a pump cannot be forced. Armature control can also be used, since the horse-power varies almost inversely as the cube of the speed. The resistance required will therefore be small, and the motor in this case will be smaller than in the first. The first cost of the armature-control outfit will usually be less, but in case a speed variation of only 25 per cent. is needed, the shunt-field control method will cost but little more, if any, and will be considerably more efficient. The variable-speed induction motor applied to this service gives results similar to direct-current armature control, and as results similar to those obtained by shunt-field control are required, the only method to secure them is to vary the frequency.

Electric motors used for driving centrifugal pumps are of three classes. One class is the alternating-current motor of constant-speed induction type. With the throttle valve completely closed, the torque required of the driving motor will be in the neighborhood of one-half full-load torque. The motors may, therefore, be started on a lower voltage, approximately 60 per cent. of full voltage, and brought up to full speed, the current at no time exceeding twice full-load current. It may be then thrown to full voltage with a very small jump in current, and the throttle valve opened to the desired extent. The simplest method is to use a single-point auto-starter or a double-throw switch. With direct-current shunt-wound motors the number of starting notches would be greater. The method of starting the variable-speed induction motor is sufficiently evident.

It may be noted that throttling is particularly prejudicial to the efficiency of the turbine type of pump in which guide vanes are used. The theoretically perfect

method would be to have the vanes of the impeller and also the guide vanes adjustable, thereby maintaining the velocity at these points constant; as discharge is then varied the efficiency would remain high by the elimination of the losses due to impact and drag at the outer limit of the impeller at any other than the rated discharge. This, however, would necessarily be a complicated arrangement. Nevertheless, future practice will probably show at least adjustable guide vanes.

TENDENCIES OF FUTURE DEVELOPMENT

Turning to a consideration of the losses, it is evident that the maximum losses in ordinary pumps are the slip or friction between the impeller and the water remaining in the pump, this affecting the efficiency only; and the drag, this affecting both efficiency and lift. The application of these pumps to increasing lifts shows the tendency toward higher speeds and compounding. It may be noted that for the same lift a multistage pump is more efficient than a single-stage pump.

Slip can be completely eliminated by surrounding the impeller with air instead of water. This can be effected in two ways: First, by properly designing the vanes of the impeller so as to make the energy of the water leaving the impeller all kinetic. The pressure in the space surrounding the impeller can thereby be made equal to or less than atmospheric, and air could then be admitted to this space. For high lift and small delivery this would result in an outlet area impracticably small. Second, the space surrounding the impeller may be filled with air at a pressure equal to the pressure on the water at that point, which with such pumps will always be considerably less than that due to the lift above the pump. Either method would completely eliminate the slip. Drag may be eliminated at rated output by the use of expanding passages or guide vanes, which to maintain the efficiency at any discharge would have to be adjustable.

The remaining losses would be reduced by accurate design of the form of vanes and finishing surfaces. Such pumps have been constructed, and as the demand arises, the results will be forthcoming. There is no reason why the efficiency of these pumps should not be made as high as 80 or even 85 per cent.

## Changing the Position of the Compound Feeding Device

BY R. MCLAREN

A compound feeder supplied by a compound manufacturer was connected as shown in Fig. 1, and in order to fill it with compound it was necessary to close the valve at the heater sufficiently to produce a "suction" on the pipe.

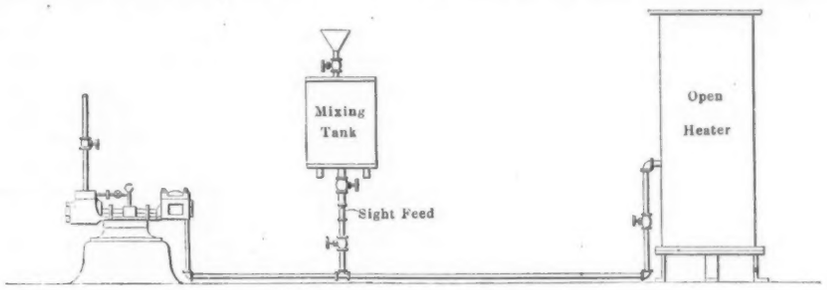



FIG. 1. AS ORIGINALLY CONNECTED UP

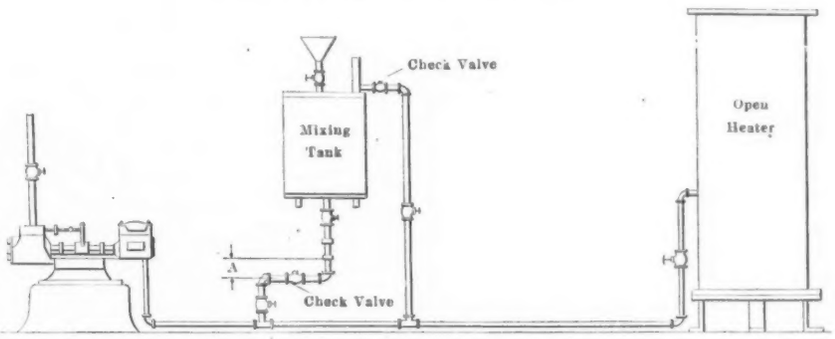



FIG. 2. AFTER THE CHANGE WAS MADE

The device was later fitted up as shown in Fig. 2. The open heater was connected with the heating system which helped to make the old arrangement more unsatisfactory. The difficulty could have been got over by giving the feeder sufficient elevation, but the inconvenience would have been intolerable.

The singing of the water in the suction pipe makes the arrangement of check valves work well.

The distance *A* should be such that the column of water and the pressure of air would be sufficient to balance the check and the pressure on the heating system, without the liquid rising to the nozzle of the sight feed.

## Treaty with Japan Relating to Patents in Korea and China

On August 6 the exchange of ratifications was made at Tokyo in regard to the recent convention with Japan, relating to the protection of trade-marks, copyrights, inventions and designs in China and Korea. Its provisions go into effect ten days after this ratification.

The articles referring to Korea provide that the Japanese government shall cause to be enforced in Korea, simultaneously with the operation of this convention, laws and regulations relative to inventions, designs, trade-marks and copyrights similar to those which now exist in Japan. The United States waives its extra-territorial jurisdiction in cases of infringement by American citizens of inventions, trade-marks, etc., entitled to protection in Korea. This places the consideration of such cases of infringement under the exclusive jurisdiction of the Japanese courts in Korea. Inventions, designs, trade-marks and copyrights duly patented or registered in Japan by the citizens of the United States, prior to the enforcement of the laws and regulations that Japan is bound by this convention to establish in Korea, shall be entitled to the same protection in Korea as is, or may be, accorded to the same properties similarly patented or registered by Japanese or Korean subjects.

The articles relating to the protection of trade in China provide that inventions, designs and trade-marks, duly patented or registered by citizens of the United States in the appropriate office of Japan, shall have in all parts of China the same protection against infringement by subjects of Japan that is accorded to them in Japanese dominions and possessions. Japanese inventions, designs and trade-marks duly patented or registered in the United States receive similar protection against infringement by United States citizens throughout all parts of China. Trade-marks falsely used by any persons amenable to the provisions of this convention must be withdrawn from the Chinese markets within a period of six months.

In this connection, American manufacturers should appreciate the difference between the Japanese trade-mark system and the American. The right to a trade-mark in the United States is based upon priority of registration. It is, therefore, of the utmost importance that American manufacturers who are interested in the protection of their trade-marks against infringement by Japanese subjects in China, Japan and Korea should register at once their right with the Japanese Patent Bureau. Information in regard to the method of procedure, reputable Japanese patent attorneys, and the like can be obtained by direct communication with the American ambassador at Tokyo.

# POWER AND THE ENGINEER

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## Increasing Demand for Anthracite

From an advance report by William W. Ruley, of the United States Geological Survey, it is of interest to note that more anthracite was shipped in 1907 than for any previous year, the total aggregating 67,109,393 long tons, as compared with 61,410,201 tons for 1905, which had previously been the banner year, and 55,698,595 tons for 1906. An average for the three years would be 61,406,063 tons, and this under normal business conditions might be said to represent the yearly demand, although these figures could only apply for a very short period of time, due to the steady, though irregular, increase in shipments of this coal.

Within the last ten years it would appear that the entire anthracite situation has changed, and completely so as far as supply and demand are concerned. Ten years ago the producing capacity of the anthracite region was in excess of the demand; today the supply and demand under normal conditions are about equal, and from all indications the demand will soon exceed the supply by a considerable margin. Although the territory in which anthracite is used to any considerable extent is limited, and there are various other competing fuels, the natural increase in the population of this territory should create a corresponding increase in the demand, and in time make the supply inadequate; moreover, the time that would otherwise elapse before this condition is reached is lessened by reason of the probable impracticability of increasing the output of the anthracite territory, even for a comparatively short time.

In connection with this general subject an interesting feature is the proportion of increase in the output of domestic sizes as well as in the small or steam sizes of anthracite. In 1890 the proportion was 76.9 per cent. of sizes above pea and 23.1 per cent. of pea and smaller sizes. In 1900 it was 64.7 and 35.3 per cent., respectively, and in 1907 the proportions changed to 58.6 and 41.4 per cent. This is a remarkable change in the percentages of sizes, although the increase in the small size coal was partially due to the washery product, which in 1907 amounted to 6.41 per cent. In 1890 this product only amounted to 0.11 per cent., so that the percentage of small coal was not materially affected. Deducting the washery product, the total shipment of sizes above pea in 1890 amounted to 28,154,678 tons, and in 1907 the tonnage was increased to 39,301,444. Shipments of pea and smaller sizes of anthracite coal aggregated 8,419,181 tons in 1890, and 23,506,867 tons in 1907. It is, therefore, plainly evident that, even after deducting the washery coal, the proportion of small sizes in fresh-mined coal has been steadily increasing, but a point to be noted in this connection is that pea coal is no longer used exclusively for making steam. There is an increasing demand for the smaller coal for domestic purposes. The exact proportion devoted to either field is not known, but conclusions drawn from these figures should be gaged accordingly.

## Efficiency versus Scale

It has been stated that "the greatest possibilities for saving or wasting about a steam plant are undoubtedly in the coal pile," or, in other words, it is much easier to effect a saving in the generation of steam than in the use of steam. The amount of energy available to the engine, or whatever prime mover is used, depends entirely on the efficiency of the boiler and its auxiliary equipment. For this reason it is of the utmost importance to develop the art of steam generation, and any advanced ideas in boiler construction are always worthy of careful consideration.

In this regard it is of interest to note the experimental work of J. H. Lester, who, with a small boiler designed to use producer gas instead of solid fuel, has obtained some remarkable results. The boiler consists simply of a copper tube of three-sixteenths of an inch internal diameter and twenty inches long, surrounded by a jacket allowing one-sixteenth of an inch space between the two tubes. The gas and air mixture enter at the top of the inner tube, and the water at the bottom of the jacket space, so that the two flow in opposite directions. By careful regulation, a flame seven inches long showing less than one-half of one per cent. of free oxygen and less than one-half of one per cent. of carbon monoxide in the exit gases can be obtained. The cooling of the gas by this countercurrent method of circulation proved so effective that the total loss of heat at the base of the combustion tube never exceeded five per cent. The steam escaped through an outlet at the top of the outer tube. An objection might be raised to the restricted space left for the water, but this construction was purposely adopted in order to prevent any downward current of water in the annular space.

In accordance with the data obtained in the experiments, a boiler of ordinary size and working under the usual operating conditions might naturally be expected to convert ninety-five per cent. of the heating value of the gas into the thermal energy of steam. Much might be said in favor of the cleanliness and convenience of such a boiler, and it would appear that this construction is by no means impossible. The one difficulty looming up above all others is the very probable possibility of scale in the limited water space. Even a thin coating would greatly check the flow of water and in a

short time the space would fill entirely. To get around this difficulty would require a supply of pure distilled water, and the expense of obtaining such a supply would in all probability more than counterbalance the advantages gained from the high efficiency.

## The Future of the Steam Engine

Some years ago we published an editorial upon "The Passing of the Piston." Recent developments suggest another reconnoiter to see how far its competitors are encroaching upon the field of the reciprocating steam engine.

That there has been a serious inroad upon this field cannot be denied nor lost sight of. For large central-station work the steam turbine has very largely supplanted the reciprocating unit, and the inverted marine type, to which practice was positively tending for large units when the turbine began to assert itself, had but a brief vogue. One builder who had started a line of these engines has abandoned his intention, and few of the builders of large reciprocating units have taken recent orders for central-station work. On the other hand, in the few years that the steam turbine has been available, the three companies making them in large capacities have taken orders for more than two and one-half million horsepower.

The steam turbine in the smaller sizes has been handicapped by its high speed, and by the fact that when run non-condensing it requires more steam than even the single-valve automatic reciprocating engine, with which it mainly competes in the smaller sizes, and much more than the four-valve engine used when the horsepower gets into the hundreds. Various methods of staging and compounding have made moderate speeds possible without too great a sacrifice of efficiency, and a number of companies are now selling these turbines to purchasers who would otherwise buy steam engines.

The development of the turbine is bringing along with it the development of its inverse, the centrifugal pump and blower. We are learning to blow and to whirl fluids where we want them, instead of pushing them; as we are learning to blow our prime movers around instead of pushing them. The centrifugal pump, which a short time ago was thought to be good only for handling large volumes of fluids under a low head, is now successfully used to feed boilers under a high pressure, and Rateau, with his compound compressor, delivers air at a pressure of seven or eight atmospheres.

In rolling-mill work, long thought to be a last safe stand for the large steam engine, a serious inroad has been made by the gas engine, which can be operated by the gas from the blast furnace, heretofore but little better than wasted. The great installations at Buffalo, South Chicago, Bessemer and Gary are examples. But it is not only where blast-furnace gas is available that the gas engine is to be reckoned with. The development of the gas producer is making the use of the internal-combustion motor generally practicable, more than a quarter of a million horsepower of moderate and large size gas engines being in operation in this country today.

Even for ship propulsion the gas engine is being urged. In a recent editorial comment upon a paper presented to the Institution of Naval Architects by James MacKechnie, *Engineering* puts forth as the leading advantages of gas engines of large size on steamships the saving of one-third of the space occupied by steam machinery and a reduction of about one-fourth in the total weight, the greater weight of the gas engine being more than offset by the smaller weight of the gas producer as compared with an equivalent capacity in steam boilers.

"Only about one-half the coal would have to be carried with gas engines as with steam engines, and there would be less than one-fourth the amount of ashes to be discharged overboard." This claim is open to discussion, for it is doubtful if the gas engine can run upon one-half the coal which is now used with the high-class marine reciprocating engine, and it is debatable if a producer will use the fuel to such advantage as to produce less than one-quarter of the ash from the same grade of fuel. Furthermore, if, as in another claim, "it is possible to use a cheaper grade of coal in the producer than in the boiler," the cheaper coal is liable to carry a larger percentage of ash, causing more rather than less ash to be made by the producer than by the boiler plant. This, however, with the modern methods of handling ashes by ejectors, is a point of very minor consequence. Moreover, it is not yet practicable to use a cheaper grade of coal in a producer than under a boiler. "Gas producers require much less attendance than boilers. The former, when once they are charged, will continue to make gas for several hours without attention." This is a very material point which might obviate the tortures of the stokehole, including the capacity of the men to crowd the boilers, which is often the limiting factor in the steam-driven plant.

It is quite likely that mechanical conveyers could be used for filling the hoppers of producers where mechanical conveying and stoking has not proved practicable with the ordinary marine-boiler plant. Another good point which is made is the saving of room by the doing away with the uptakes, and the saving in wind resistance and obstruction of view (and guns, in the case of naval vessels) by the abolishment of the enormous smokestacks. Another advantage is the fact that each cylinder is a complete gas engine in itself, and that should several of the cylinders be put out of commission, the shaft could be turned as long as there was one cylinder in working order.

The chief disadvantage urged is the high temperature inseparable from the use of cylinders of large size. It is not plain why this is any more material in marine than in stationary practice. The author says: "When gas engines are designed especially for marine work they will be provided with thin water-cooled pistons; they will be double-acting and will be fitted with crossheads and slides, similar to those used upon steam engines." All this is true of any of the gas engines made in large sizes for any kind of service. The principal disadvantage would appear to us to be in the large number of cylinders which in the present state of the art it would be necessary to employ to obtain the horsepower required to drive a large ocean liner. There seems to be no good reason why larger diameters may not be used, but up to the present, designers have not trusted themselves to much, if any, above fifty inches in diameter. A double-acting two-stroke-cycle engine, with eighty pounds mean effective pressure and nine hundred feet piston speed, will develop just about two horsepower per square inch of piston area; and with fifty-inch cylinders, having sixteen-inch piston and tail rods, it would take fourteen cylinders to develop fifty thousand horsepower. Beardmore, the English builder, put out a gas-driven coaster a couple of years ago, which, we understand, was not a success; but it is obvious that there are possibilities in the line of marine propulsion for the internal-combustion engine.

Another onslaught upon the reciprocating steam engine as the chief of prime movers is the concerted and powerful movement in the direction of the conservation of our resources by the development of the water powers of the country. The State geologist of Wisconsin estimates that the development of the water powers of that State would save its people something like a million dollars' worth of coal a year, and the State Water Supply Commission of New York estimates the annual earning capacity of the wasted energy in water in that State at six million six hundred thousand dollars annually. Water commissions are getting at work in all the States, and there is no doubt that much money will be spent in the early future in developing water powers, and in electrical transmission, which would otherwise be spent for reciprocating steam engines.

The reciprocating steam engine has the advantage of establishment and reliability, and it has a great advantage in places where steam is required for heating or manufacturing purposes. Where its exhaust can be usefully applied in this way its thermal efficiency is very high, and no other source of power can approach it in the low cost at which it can deliver energy.

# Power Plant Machinery and Appliances

**Original Descriptions of Power Devices**
**No Manufacturers' Cuts or Write-ups Used**

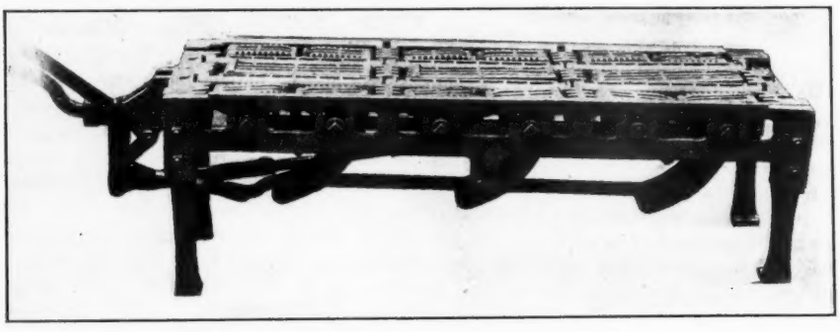
## MUST BE NEW OR INTERESTING

### Improvements in the Blackburn-Smith Feed Water Filter

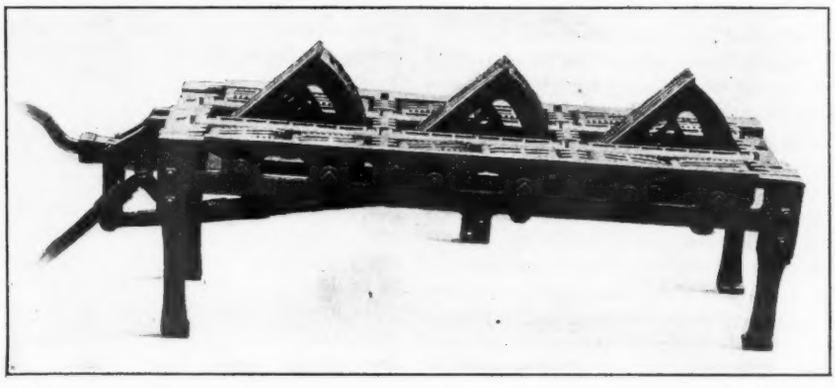
The principal improvement which has been made in the filter lies in the arrangement of the valve mechanism. In the old model, illustrated and described in the August, 1907, POWER, the feed pipe left the filter on a different axis than that on which it entered. In the new arrangement the feed pipe remains in a straight line, the bypass is self-contained within the feed line, and practically the whole filter can be removed for cleaning or otherwise, without disturbing the line. Other changes are the use of swing bolts to hold the cover in place, the air cock on the top of the cover and an improved water-relief valve to prevent automatically excessive pressure in the pump-discharge line. The inlet and outlet valves are entirely independent of each other, so that whatever may affect the closing of one does not affect the other. This filter is manufactured by James Beggs & Co., 109 Liberty street, New York City.

### The New Reagan Grate

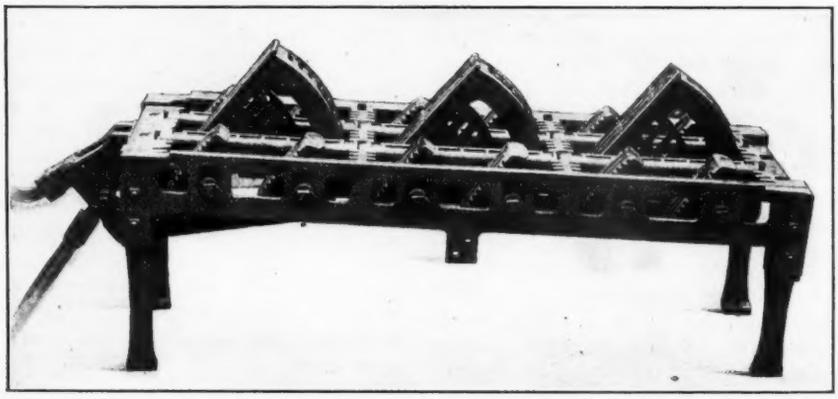
The Reagan Grate Bar Company, of Philadelphia, is directing attention to its new apparatus for mechanically stoking bituminous-coal fires, the purpose of the device being to obviate the use of a stoker bar and to permit the fire to be stoked without having to open the fire doors.



VIEW OF REAGAN GRATE AT REST



SHOWING PURPOSE OF STOKING DEVICE



SHOWING STOKING DEVICE AND CHOPPERS IN USE

The construction is very simple. It consists of a series of lifting fire bars extending the entire length of the grate. Means for actuating the sections are attached to a shaking device which operates the choppers but which is independent of the choppers, although if desired it can be operated in connection with them. The accompanying illustrations show very clearly the construction and operation, and it is conceivable that the fire can be kept in an efficiently porous condition and the bad effects of clinkers avoided. As will be seen, the stoking device is air-cooled.

### Grab Bucket Monorail Crane

The monorail crane shown on page 381 is for use on an I-beam runway and is provided with swivel trucks so as to enable it to go around a curve of short radius. It is regularly furnished with a two-line grab bucket. Both hoist and holding drums are operated by one motor, by means of friction clutches controlled from the operator's cage. The lowering of the bucket and the operations of opening and closing are effected by gravity, and the motor is inoperative when the bucket is being lowered or opened.

After the bucket has been lowered to the fuel pile or car the clutch is closed, after which time the clutch for the holding drum is engaged and the two are utilized for lifting the load. When the bucket has reached its highest position it is sustained by a self-lubricating mechanical brake of the double-friction type.

To relieve the hoisting clutches of undue wear during the process of lowering

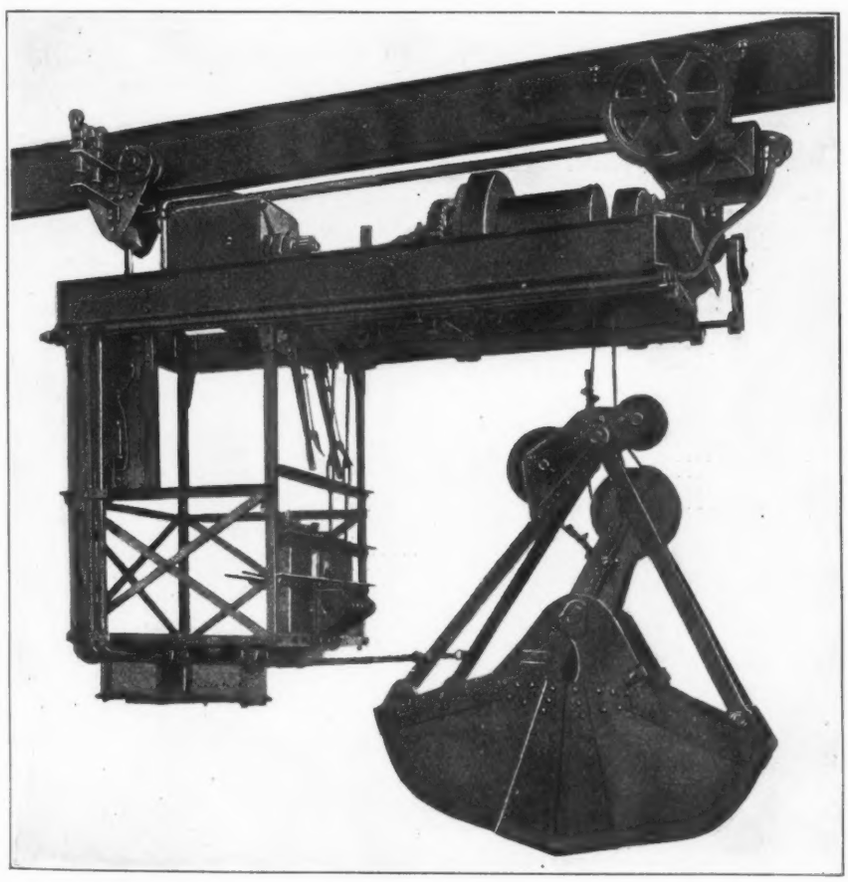
the bucket, the hoisting drums are provided with band brakes controlled by foot levers from the operator's cage. The friction clutches used for raising the load act as safety devices in case of over-hoisting, since the clutches are so designed that they will slip before the stresses had reached a dangerous point.

The intermediate hoisting shaft is extended to the rear end of the operator's cage and is provided with a drum that rotates at about twice the peripheral speed of the hoisting drums. This drum has attached to it a rope which extends to the grab bucket and is used for steadying it; not only while in the process of being elevated, but after the bucket has reached its final position and is being carried to its destination. The rope is kept taut by means of a friction drum revolving between two disks keyed to the shaft, with feather keys and held against the drum by means of spiral springs made adjustable for wear and also to vary the pressure between the friction services. The springs exert a pull on the steady rope of from 250 to 300 pounds as the bucket is being raised or lowered.

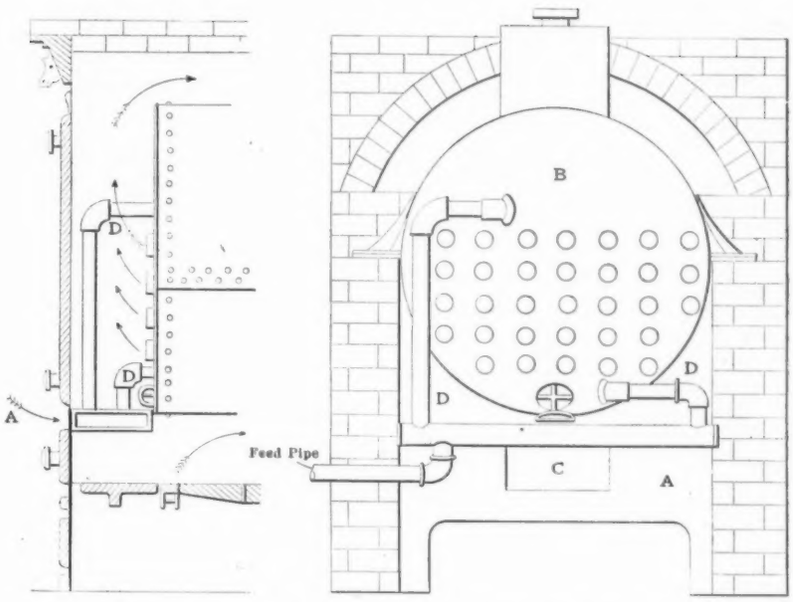
A racking motor is attached to the driving truck and its speed is regulated by a drum-type controller located in the operator's cage. The travel of the hoist may be made to suit almost any condition, but in ordinary practice a speed of from 300 to 500 feet per minute will be found sufficient for coal-handling plants, especially where there is a curve or bend in the I-beam along the runway.

The treads of the track wheels for the driving and trailing trucks are made spherical, the object being to eliminate friction as far as possible.

The monorail hoist is manufactured by the Cleveland Crane and Car Company, Wickliffe, Ohio.



GRAB BUCKET MONORAIL CRANE




END AND FRONT VIEW OF WATER-SPACE ARCH PLATE

## Water Space Arch Plate for Steam Boilers

These arch plates are constructed of steel plates, which are subjected to the same tests and working pressures as a steam boiler. The arrow at *A* in the end view points to the arch plate, the hollow space being for water. The arch plate is connected to the circulation pipes, indicated by *D*, which in turn are connected to the boiler, as shown at *B* (front view). The furnace door over these plates is shown at *C*. This position is exceedingly hot, and soon destroys cast-iron and brick.

These plates are always full of water, and being connected to the boiler, a constant circulation is kept up. It is said that the only effect the heat has on these plates is to increase the efficiency of the boiler by the additional heat taken up by the water-space arch plates. The plates need no more attention than the boiler. If desired, the water from a heater can be pumped through the arch, thus adding additional heat to the water before entering the boiler, or the plate may be connected to the pump direct.

This device is manufactured by George Fox's Sons, 511 West Thirty-fourth street, New York City.

## Personal

Herbert Self, for several years connected with the New York office of the Crandall Packing Company, has become associated with the Keystone Lubricating Company, of Philadelphia, and will make his headquarters at the New York office of that company, at 96 Warren street.

## Business Items

The Schaeffer & Budenberg Manufacturing Company has sold its factory buildings at Foxboro, Mass., and removed its main office, works and New York salesrooms to 963 and 965 Kent avenue, Brooklyn, N. Y.

After September 1 the main offices of the Bird-Archer Company, will occupy the twenty-second floor of the West street building, New York city. The new offices contain more than four times the floor space of the present seven-room offices. This quadrupling of floor space was made necessary by an unpectedly large increase in business during the short time in which the company has occupied the present offices. It is of interest to note that the Bird-Archer Company did not recall its sales forces or retrench in any way during the recent business depression and that this continued activity resulted in a practically normal American trade and an export trade which continued brisk without interruption. The demand for boiler compounds in the Orient especially seems to be very promising as the company now sends out its Asian shipments in five-car lots. These are usually consigned to Pacific coast agents, who reship to the foreign agents and customers. P. B. Bird, president of the company, also expresses the opinion that American industry must be active in Cuba, as the demand for boiler compounds on the island has grown beyond all prophesies. The Bird-Archer Company now has offices, or representatives in every city of importance in the country, and also has agents located all over the world.

Designers and builders of boilers, as well as engineers generally, will be interested in the seventh edition of a book entitled, "Morison Suspension Furnaces for Internal Furnace Boilers," just issued by the Continental Iron Works, Brooklyn, N. Y. The book deals with the use of the Morrison suspension furnaces in connection with land boilers only, in contradistinction to the application of these furnaces for marine purposes. It is a finely compiled and printed volume of nearly seventy pages, bound in a serviceable cover. There are many valuable data, with numerous illustrations, including a number of important installations of internal furnace boilers using the Morison suspension furnace, together with details of design and construction, tables of pressure and thickness, and rules for calculating them. The designs shown are for land boilers ranging from 50 to 300 horsepower, and are intended to meet general requirements, it being explained that where boilers are designed to work under other than normal conditions the designs are offered by way of suggestion only. A form of specification for internal-furnace tubular boilers, which accompanies the designs, should prove an important aid. In the latter part of the book is a partial list of installations. This is followed by illustrations and full information regarding the Morison patent furnace fronts and doors, which are also made only by the Continental Iron Works.

## Help Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent packing salesmen. The Henry Johnson Co., 175-187 Gates Ave., Jersey City, N. J.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

STEAM ENGINE ERECTING ENGINEER, capable of assisting in sales department, young man with shop experience and wide acquaintance among Eastern engineers preferred. Box 33, POWER.

## Situations Wanted

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

POSITION as superintendent or manager. Wide and successful experience in marine, mill, pumping engines, hydraulic and steam turbines and Corliss engine manufacture, installation and operation. Box 26, POWER.

CHIEF ENGINEER of large industrial plant desires change; active and alive, an expert with indicators and testing apparatus, can keep operating expenses at proper figures. Box 27, POWER.

ENGINEER, three years in present position, having charge of 2000 H.P. plant, desires a change. Capable of taking charge of a plant of this or larger size. Good reference. "L. M.," POWER.

POSITION WANTED as chief engineer; experienced with all kinds of engines, steam turbines, a.c. and d. c. generators, motors and switchboards, boilers and pumps; I can get results and furnish the references; have been seventeen years in the mechanical and engineering business. Box 9, POWER.

POSITION by technical graduate, with four years experience in steam turbines, gas engines, drafting, etc., as instructor in mechanical engineering with or without opportunity to do post graduate work. Box 35, POWER.

SITUATION WANTED by competent steam specialty or boiler and engine salesman. Box 36, POWER.

## Miscellaneous

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

WANTED—A second hand Corliss engine, 100 to 150 H.P. Must be in first class condition. Box 34, POWER.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

IF YOU DESIRE to learn the latest improvement in steam boilers, correspond with the Detroit Water Tube Boiler Co., Detroit.

ENGINES AND BOILERS, ¼ to 2 h.p., engine castings in sets. Models and general machine work. Sipp Electric and Machine Co., Paterson, N. J. Catalog 4c.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make free examination and report if patent can be had, and exact cost.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

ENGINEERS, firemen, electricians, machinists, etc. New 25-page pamphlet containing questions asked by the examining boards sent free upon request. Geo. A. Zeller Book Co., 4168 W. Belle Place, St. Louis, Mo. Established 1870.

## For Sale

*Advertisements under this head are inserted for 25 cents per line. About six words make a line.*

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—500 H.P. double Corliss engine, 250 H.P. each side, 23x26, slow speed. This engine is in excellent condition and can be had at a bargain. Address, Fall River Bleachery, Fall River, Mass.

FOR SALE—One 66" new American turbine, with core wheel, bridge tree pinion and 4" shafting in good condition. Cheap. Address De Pere Electric Light and Power Co., De Pere, Wis.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24-in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—Two 60"x16' H. T. boilers; two 52"x16' H. T. boilers; one 8"x10", 125 R. P. M., Imperial engine, direct connected to 25 kw., 125 V., direct current Triumph generator; one 7"x8", 375 R. P. M., direct connected to 10 kw., 125 V., direct current generator; one 20 H.P. 500 V. Edison motor; one 7½ H.P. one 3 H.P., and one ½ H.P., 500 V., direct current General Electric motor. Address Thompson Hotel Company, Lincoln, Neb.

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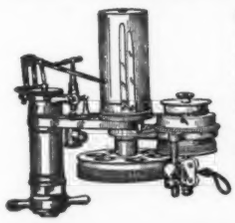

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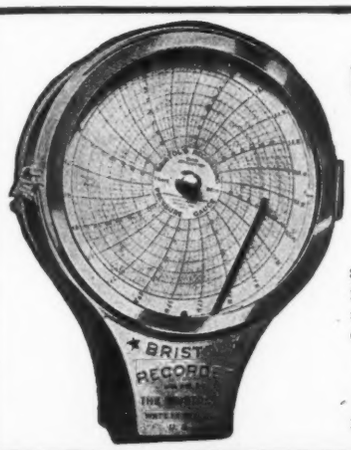

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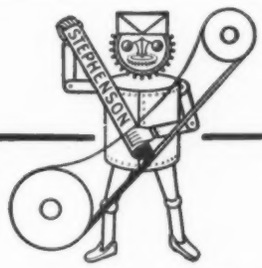


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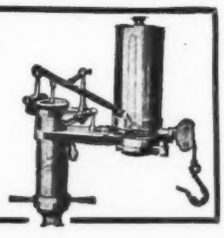

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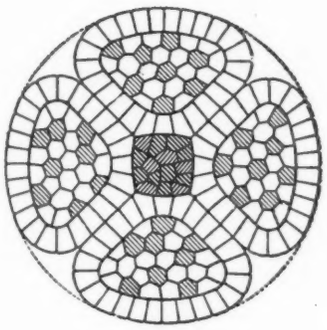

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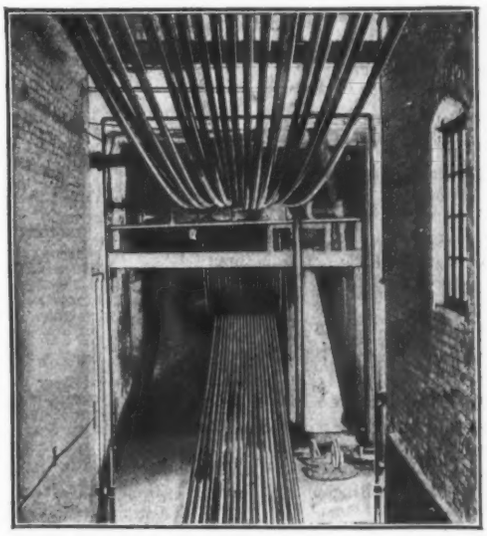

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Central Station Steam Co., Detroit, Mich.

**Gaskets, Leather**

Detroit Leather Specialty Co., Detroit, Mich.

**Gaskets, Water Gage**

Johnson Co., Henry, Jersey City, N. J.
Morse, R. F., Providence, R. I.

**Gears**

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Process Raw Hide Co., Syracuse, N. Y.

**Generating Sets**

American Engine Co., Bound Brook, N. J.
C & C Electric Co., New York.
Engberg's Electric & Mechanical Works, St. Joseph, Mich.
Foos Gas Engine Co., Springfield, Ohio.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, Ohio.

**Governors, Pump**

American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Davis Co., John, Chicago, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Gardner Governor & Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

**Graphite**

Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.

**Grates, Chain Traveling**

Green Engineering Co., Chicago, Ill.

**Grates, Clinker Cutting**

McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.

**Grates, Dumping**

Beggs & Co., James, New York.
Martin Grate Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

**Grates, Rocking**

Martin Grate Co., Chicago, Ill

**Grates, Shaking**

Martin Grate Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Robertson & Sons, Jas. L., New York.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

**Grates, Stationary**

Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.

**Grease**

Cook's Sons, Adam, New York.
Dixon Crucible Co., Jos., Jersey City, N. J.
Harris Oil Co., A. W., Providence, R. I.
Kellogg & Co., E. H., New York.
Keystone Lubricating Co., Philadelphia, Pa.
N. Y. & N. J. Lubricant Co., New York.

**Grease Extractors**

Beggs & Co., James, New York.
Griscom-Spencer Co., New York.
Hussey, McCann & Co., New York.

**Heating and Ventilating Systems**

Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Webster & Co., Warren, Camden, N. J.
Wing Mfg. Co., L. J., New York.

**Hoists**

Northern Engineering Works, Detroit, Mich.

**Hose**

Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Works, San Francisco, Cal.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Lagonda Mfg. Co., Springfield, O.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Myers & Bro., F. E., Ashland, O.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.

**Hose, Air**

Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

**Hose, Oil**

Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

**Hose, Steam**

Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

**Hose, Water**

Anchor Packing Co., Philadelphia Pa.
Diamond Rubber Co., Akron, Ohio.
Restein Co., Clement, Philadelphia, Pa.

**Indicators, Gas Engine**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

**Indicators, Speed**

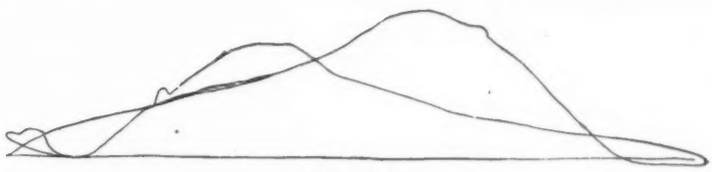
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Starrett Co., L. S., Athol, Mass.

**Indicators, Steam Engine**

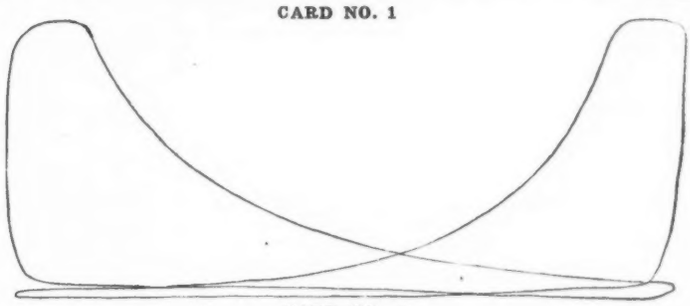
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.

# $100. EXPENDED FOR

## The American-Thompson Improved Indicator Saved $4.00 Each Day



CARD NO. 1



CARD NO. 2

**Card No. 1** ¶ Actual reproduction of an Indicator diagram where the boilers consumed 4000 lbs. coal each day. In addition to the coal consumption, shavings and waste wood were burned.

**Card No. 2** ¶ Illustrates first reading after valves were set and resulted in no coal burned, shavings and waste wood being sufficient fuel to develop horse power required.

This is only one of the many instances where The American-Thompson Improved Indicator has

## SAVED ITS OWN COST IN A MONTH

If your jobber does not carry "The American" specialties and will not procure them for you, we will ship to you direct from our factory.

WRITE FOR CIRCULAR 2-D.

## American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 835 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex
Montreal, 444 St. James St.

San Francisco, 247 Pine St.
Los Angeles, 213 So. Los Angeles St.

**Indicators, Steam Engine** —*Continued.*
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co, Foxboro, Mass.
Star Brass Mfg. Co., Boston, Mass.
Trill Indicator Co., Corry, Pa.

**Injectors**
American Injector Co., Detroit, Mich.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Machinery Co., Cincinnati, Ohio.
Robertson & Sons, Jas. L., New York.
Schutte & Koerting Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

**Joints, Expansion**
Alberger Condenser Co., New York.
Central Station Steam Co., Detroit, Mich.
Webster & Co., Warren, Camden, N. J.

**Joints, Pipe**
McCrea & Co., James, Chicago, Ill.

**Joints, Rubber**
Diamond Rubber Co., Akron, Ohio.

**Lace, Leather**
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

**Lamps, Arc**
General Elec. Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Lamps, Incandescent**
General Elec. Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Lathes, Foot Power**
Barnes Co., W. F. & John, Rockford, Ill.

**Lubricants**
Cook's Sons, Adam, New York.
N. Y. & N. J. Lubricant Co., New York.
United States Mica Co., Chicago, Ill.

**Lubricating and Oiling Devices**
Lunkenheimer Co., Cincinnati, O.
Nugent & Co., W. W., Chicago, Ill.

**Lubricators**
Cook's Sons, Adam, New York.
Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Griscom-Spencer Co., New York
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Michigan Lubricator Co., Detroit, Mich.
Ohio Injector Co., Wadsworth, O.
Powell Co., Wm., Cincinnati, O.
Robertson & Sons, Jas. L., New York.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.
Stephenson Mfg. Co., Albany, N. Y.
Sterling Lubricator Co., Rochester, N. Y.

**Machinery, Second Hand**
Hewes & Phillips Iron Works, Newark, N. J.
Randle Machinery Co., Cincinnati, Ohio.
Wickes Bros., Saginaw, Mich.

**Machines, Ice**
Vilter Mfg. Co., Milwaukee, Wis.

**Machines, Pipe Cutting and Threading**
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Crane Co., Chicago, Ill.
Curtis & Curtis Co., Bridgeport, Conn.

**Machines, Pipe Cutting and Threading** —*Continued.*
Loew Mfg. Co., Cleveland, O.
Toledo Pipe Threading Machine Co., Toledo, Ohio.
Trimont Mfg. Co., Roxbury, Mass.

**Machinists, General**
American & British Mfg. Co., Providence, R. I.
Bruce-Meriam-Abbott Co., Cleveland, O.
Mathews, Hugh, Kansas City, Mo.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Providence Engineering Works, Providence, R. I.

**Mats & Matting, Rubber**
Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.

**Mechanical Draft**
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

**Metal, Anti-friction**
Allan & Son, A., New York.

**Metal, Bearing**
Allan & Son, A., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

**Metal Polish**
Hoffman, Geo. W., Indianapolis, Ind.

**Meters, Steam**
St. John, G. C., New York.

**Micrometers**
Starrett Co., L. S., Athol, Mass.

**Mill Supplies**
Quaker City Rubber Co., Philadelphia, Pa.

**Milling Machines, Portable**
Underwood & Co., H. B., Philadelphia, Pa.

**Mining and Smelting Machinery**
Moore & Co., Chas. C., San Francisco, Cal.

**Motors and Dynamos**
American Engine Co., Bound Brook, N. J.
C & C Electric Co., New York.
Clark Bros. Co., Belmont, N. Y.
General Elec. Co., Schenectady, N. Y.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, Ohio.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Motors, Water**
Lagonda Mfg. Co., Springfield, O.

**Nipples**
National Tube Co., Pittsburg, Pa.

**Oil and Grease Cups**
American Injector Co., Detroit, Mich.
Cook's Sons, Adam, New York.
Griscom-Spencer Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Sherwood Mfg. Co., Buffalo, N. Y.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Oil Burners**
Hammel Oil Burner Co., Los Angeles, Cal.

**Oil Dash Pots**
Lammert & Mann, Chicago, Ill.

**Oil Reservoirs**
Burt Mfg. Co., Akron, O.

**Oilers, Crank Pin**
Penberthy Injector Co., Detroit, Mich.

**Oiling Systems**
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

**Oils**
Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
Harris Oil Co., A. W., Providence, R. I.
Kellogg & Co., E. H., New York.
New York & New Jersey Lubricant Co., New York.

**Oils, Non-fluid**
N. Y. & N. J. Lubricant Co., New York.

**Packing, Asbestos**
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Restein Co., Clement, Philadelphia, Pa.

**Packing, Flange**
Carey Co., Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robertson & Sons, Jas. L., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

**Packing, Hydraulic**
Anchor Packing Co., Philadelphia, Pa.
Brandt, Randolph, New York.
Detroit Leather Specialty Co., Detroit, Mich.
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Schieren Co., Chas. A., New York.

**Packing, Metallic**
American Huhn Metallic Packing Co., New York.
Anchor Packing Co., Philadelphia, Pa.
Bridgeport Metallic Packing Co., Bridgeport, Conn.
Garlock Packing Co., Palmyra, N. Y.
Houchin-Aiken Co., Brooklyn, N.Y.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Tripp Metallic Packing Co., Boston, Mass.

**Packing, Piston**
American Steam Packing Co., Boston, Mass.
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Works, San Francisco, Cal.
Carey Co., Philip, Cincinnati, O.
Diamond Rubber Co. Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co New York.

**Packing, Piston**—*Continued.*
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Underwood & Co., H. B., Philadelphia, Pa.

**Packing, Pneumatic**
Detroit Leather Specialty Co., Detroit, Mich.
Mercer Rubber Co., Hamilton Square, N. J.

**Packing, Pump Valve**
Anchor Packing Co., Philadelphia, Pa.
Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

**Packing, Rod**
American Huhn Metallic Packing Co., New York.
Anchor Packing Co., Philadelphia, Pa.
Bowers Rubber Co., San Francisco, Cal.
Brandt, Randolph, New York.
Bridgeport Metallic Packing Co., Bridgeport, Conn.
Carey Co., Philip, Cincinnati, O.
Diamond Rubber Co., Akron, Ohio.
Flower Steam Specialty Co., Walter L., St. Louis, Mo.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Sayen, Osgood, Philadelphia, Pa.
Steel Mill Packing Co., Detroit, Mich.

**Packing, Valve Stem**
Diamond Rubber Co., Akron, Ohio.
Home Rubber Co., Trenton, N. J.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.

**Pipe**
Ball & Wood Co., Elizabethport, N. J.
Central Station Steam Co., Detroit, Mich.

**Pipe, Riveted Steel**
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

**Pipe, Wrought**
National Tube Co., Pittsburg, Pa.

**Pipe Bending**
Ball & Wood Co., Elizabethport, N. J.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

**Pipe Clamp**
Simplex Engineering Co., Philadelphia, Pa.

**Pipe Coils, Brass, Iron and Copper**
McCrea & Co., James, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Whitlock Coil Pipe Co., Hartford, Conn.

**Pipe Fittings**
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
McCrea & Co., James, Chicago, Ill.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburg Valve & Fittings Co., Barberton, Ohio.
Pittsburg Valve, Foundry and Construction Co., Pittsburg, Pa.
Trimont Mfg. Co., Roxbury, Mass.

# Websterizing

## A Monthly Bulletin For Steam Engineers

VOL. 1. SEPTEMBER, 1908. NO. 3.

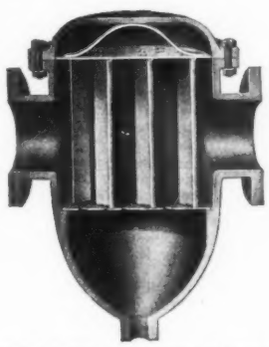
A steam plant cannot be operated economically unless there's perfect harmony between the component parts. A certain sense of proportion must be maintained or there will be a waste.

If you have to overwork the coal pile to make the boilers do their work, then your plant is out of harmony, and you'll see the result in larger fuel bills.

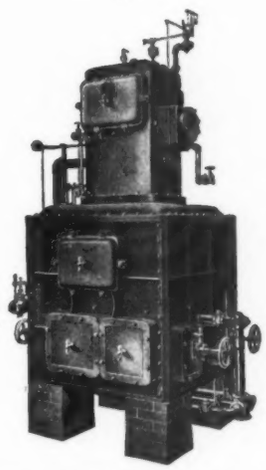
If your feed water contains impurities that injure your boilers, you'll get expense, delay and trouble instead of profitable efficiency.

These are two illustrations—and there are many more—that prove how important steam plant "harmony" can become.

The best of boilers and engineers cannot give satisfactory service if they are handicapped by unfavorable conditions, and it is the function of Webster Steam Specialties to "harmonize" the parts of the power plant and make each part work most efficiently and economically. That's why it pays to "Websterize."



WEBSTER OIL SEPARATOR.



WEBSTER CHEMICAL PURIFIER.

Among the many devices for the profitable utilization of exhaust steam the Webster Oil Separator has been prominent for over 20 years. Used with the Webster Heater (as nearly 4000 of them are today) it renders the condensation of exhaust steam fit for use as boiler feed.

This is only one of the types of Separators, for Oil and Steam, that we make. If you need them for any special purposes, we can meet your requirements to the letter.

Separator Booklet 12-S describes these devices.

Where the water supply for a power plant is especially bad, a purifier is absolutely necessary and, naturally, the better the device the more satisfactory the results will be.

The Webster Chemical Purifier treats the water *while it is hot* with chemicals selected to suit that particular case, and there is never any doubt as to the results. We will not install a "Webster" until we *know* by investigation and analysis, that it is fully capable of doing its work right. It makes the location of the plant entirely independent of the water supply.

Chemical Purifier Booklet, 12-C, describes in detail.

The illustration below shows the Class "ED" Webster Heater.

We make a number of different types of heaters and each has its particular purpose.

The Class "ED" Heater is used where there is limited head room, and is so proportioned as to give unusually large storage space.

Laundries, tanneries, dye houses, breweries, or other establishments requiring large quantites of water for other purposes than boiler feed will find this type of heater suitable for their needs.

Write for Heater Booklet 12-F.

WEBSTER FEED WATER HEATER, PURIFIER AND FILTER.

9

Warren Webster & Co., Camden, N.J.

**Pipe Joints, Compound**
Dixon Crucible Co., Jos., Jersey City, N. J

**Planimeters**
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

**Plumbago**
Dixon Crucible Co., Jos., Jersey City, N. J.

**Power Plant Supplies**
Safety Equipment Mfg. Co., Chicago, Ill.

**Producers, Gas**
Broomell, Schmidt & Steacy Co., York Pa
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Power & Mining Mach. Co., Cudahy, Wis.

**Publishers**
American School of Correspondence, Chicago, Ill.
Hill Publishing Co., New York.
International Correspondence Schools, Scranton, Pa.

**Pulleys**
American Pulley Co., Phila., Pa.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Philips Pressed Steel Pulley Works, Philadelphia, Pa.

**Pulleys, Clutch**
Williams Foundry & Mach. Co., Akron, Ohio.

**Pumps, Air**
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

**Pumps, Boiler Feed**
Kewanee Boiler Co., Kewanee, Ill.

**Pumps, Centrifugal**
Alberger Condenser Co., New York.
Morris Machine Works, Baldwinsville, N. Y.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

**Pumps, Electric**
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

**Pumps, Force-feed Oil**
Sterling Lubricator Co., Rochester, N. Y.

**Pumps, Hydraulic**
Goulds Mfg. Co., Seneca Falls, N. Y.

**Pumps, Oil**
Burt Mfg. Co., Akron, O.
Detroit Lubricator Co., Detroit, Mich.
Du Bois Iron Works, Du Bois, Pa.
Goulds M g. Co., Seneca Falls, N. Y.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.

**Pumps, Power**
Deming Co., Salem, Ohio.
Myers & Bro., F. E., Ashland, O.
Patterson & Co., Frank L., New York.
Stewart Heater Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.

**Pumps, Steam**
Buffalo Steam Pump Co., Buffalo, N. Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Gardner Governor and Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Minneapolis Steel & Machry. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Safety Equipment Mfg. Co, Chicago, Ill.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

**Pumps, Triplex**
Minneapolis Steel & Mchry. Co., Minneapolis, Minn.

**Pumps, Turbine**
Alberger Condenser Co., New York.

**Pumps, Vacuum**
Alberger Condenser Co., New York.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Wheeler Condenser & Engineering Co., New York.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

**Rams, Steam**
Penberthy Injector Co., Detroit, Mich.

**Reducing Wheels**
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.
Trill Indicator Co., Corry, Pa.

**Refractories**
Harbison-Walker Refractories Co., Pittsburg, Pa.

**Refrigerating Machinery**
De La Vergne Machine Co., New York.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
York Mfg. Co., York, Pa.

**Regulators, Damper**
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.
Robertson & Sons, Jas. L., New York.
Strong, Carlisle & Hammond Co., Cleveland, O.

**Regulators, Feed Water**
American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Jerguson Mfg. Co., Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Mason Regulator Co., Boston, Mass.
Murray Automatic Boiler Feed Co., Detroit, Mich.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.

**Regulators, Pressure**
American Boiler Economy Co., Philadelphia, Pa.
American District Steam Co., Lockport, N. Y.
Davis Regulator Co., G. M., Chicago, Ill.
Fisher Governor Co., Marshalltown, Iowa.
Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.
Ohio Brass Co., Mansfield, Ohio.
Strong, Carlisle & Hammond Co., Cleveland, O.

**Regulators, Rheostat**
Mason Regulator Co., Boston, Mass.

**Repairs, Engine and Pump**
Underwood & Co., H. B., Philadelphia, Pa.

**Reseating Machines, Flue Cap**
Lagonda Mfg. Co., Springfield, O.
Leavitt Machine Co., Orange, Mass.
Liberty Mfg. Co., Pittsburg, Pa.

**Revolution Counters**
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

**Rope Dressing**
Cling Surface Co., Buffalo, N. Y.

**Rope Transmission**
American Mfg. Co., New York.
Plymouth Cordage Co., No. Plymouth, Mass.

**Rubber Goods**
Diamond Rubber Co., Akron, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Griscom-Spencer Co., New York.
Home Rubber Co., Trenton, N. J.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co, Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Philadelphia, Pa.

**Schools, Correspondence**
American School of Correspondence, Chicago, Ill.
International Correspondence Schools, Scranton, Pa.

**Separators, Ammonia**
Harrison Safety Boiler Works, Philadelphia, Pa.

**Separators, Oil**
Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
Direct Separator Co., Syracuse, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Hussey, McCann & Co., New York.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Webster & Co., Warren, Camden, N. J.
Wright Mfg. Co., Detroit, Mich.

**Separators, Oil and Water**
Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

**Separators, Steam**
Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
d'Este & Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Gardner Governor and Separator Co., Quincy, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Patterson & Co., Frank L., New York.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

**Separators, Steam**—*Continued*
Sims Co., Erie, Pa.
Webster & Co., Warren, Camden, N. J.
Whitlock Coil Pipe Co., Hartford, Conn.
Wright Mfg. Co., Detroit, Mich.

**Shafts, Counter**
Myers & Bro., F. E., Ashland, O.

**Sheaves**
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

**Skimmers, Boiler**
Buckeye Boiler Skimmer Co., Toledo, Ohio.

**Skylights**
Burt Mfg. Co., Akron, O.

**Smoke Preventers**
Climax Smoke Preventer Co., Boston, Mass.

**Spray Nozzles**
Schutte & Koerting Co., Philadelphia, Pa.

**Stacks, Steel**
Bigelow Co., New Haven, Conn.
Keeler Co., E., Williamsport, Pa.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Morrin Climax Boiler Co., Brooklyn, N. Y.

**Steam Heating Supplies**
Beggs & Co., James, New York.
Crosby Steam Gage & Valve Co., Boston, Mass.
Dunham Co., C. A., Marshalltown, Iowa.
Eastwood Wire Mfg. Co., Belleville, N. J.
Fisher Governor Co., Marshalltown, Iowa.
Nason Mfg. Co., New York.
New York Belting & Packing Co., New York.
Ohio Brass Co., Mansfield, O.
Peerless Rubber Mfg. Co., New York.
Reliance Gauge Column Co., Cleveland, O.
Strong, Carlisle & Hammond Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

**Steam Specialties**
Crane Co., Chicago, Ill.
Ohio Brass Co., Mansfield, Ohio.

**Stocks, Die**
Armstrong Mfg. Co., Bridgeport, Conn.
Toledo Pipe Threading Machine Co., Toledo, O.

**Stokers, Mechanical**
Detroit Stoker and Foundry Co., Detroit, Mich.
Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Westinghouse Mach. Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

**Storage Batteries**
Westinghouse Machine Co., Pittsburg, Pa.

**Strainers**
American Injector Co., Detroit, Mich.
Liberty Mfg. Co., Pittsburg, Pa.
Webster & Co., Warren, Camden, N. J.

**Superheaters**
Babcock & Wilcox Co., New York.
Parker Boiler Co., Philadelphia, Pa.
Power Specialty Co., New York.
Providence Engineering Works, Providence, R. I.

**Switchboards**
C & C Electric Co., New York.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Switches, Electric**
General Electric Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Syphons**
National Tube Co., Pittsburg, Pa.
Schutte & Koerting Co., Philadelphia, Pa.

At a recent boiler inspection the inspector made a report which brought consternation into a comfortable office and the boiler room as well. In order to verify the verdict the manager sent to a boiler manufacturer and had his man inspect the boilers.

When this man crawled out of the boiler, he said to the engineer, "What have you been using in these boilers?"

The engineer said, "Our own home-made compound."

"Is that so," said the expert. "Well, all I have got to say is this: You make your line of machinery and we make boilers and neither of us are equipped to make anything else. There is a concern equipped with the experience and the plant to make boiler compound and about the best thing you can do is to stop trying to do work that you are not up-to-date on and go to the Geo. W. Lord Company and have the job done right. Your boiler compound don't fit this case at all. You have been trying to get rid of scale and in the meantime the boilers have corroded."

The secret is not whether the boiler compound is good, it is, what does the water contain? This can only be learned by an analysis.

In order to get information on this matter send for our booklet, "Boiler Scale, Its Formation and Removal."

**George W. Lord Co.,**
**2238-2250 North 9th St.,**
**Philadelphia, Penna.**

**Tanks**

Bigelow Co., New Haven, Conn.
Griscom-Spencer Co., New York.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

**Taps and Dies**

Toledo Pipe Threading Machine Co., Toledo, O.

**Thermometers**

Bristol Co., Waterbury, Conn.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

**Tools**

Mound Tool & Scraper Co., St. Louis, Mo.
Trimont Mfg. Co., Roxbury, Mass.

**Transformers and Converters**

General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

**Transmission**

American Mfg. Co., New York.
American Pulley Co., Philadelphia, Pa.
Gandy Belting Co., Baltimore, Md.
Jeffrey Mfg. Co., Columbus, O.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Plymouth Cordage Co., No. Plymouth, Mass.
Rhoads & Sons, J. E., Philadelphia, Pa.

**Traps**

American District Steam Co., Lockport, N. Y.
Anchor Packing Co., Philadelphia, Pa.
Anderson Co., V. D., Cleveland, O.
Central Station Steam Co., Detroit, Mich.
Davis Co., John, Chicago, Ill.
Davis Regulator Co., G M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Dunham Co., C. A., Marshalltown, Iowa.
Flinn, Richard J., W. Roxbury Station, Boston, Mass.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Nason Mfg. Co., New York.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.
Webster & Co., Warren, Camden, N. J.
Williams Valve Co., D. T., Cincinnati, Ohio.
Wright Mfg. Co., Detroit, Mich.

**Trucks, Storage Battery Auto-**

Westinghouse Mach. Co., Pittsburg, Pa.

**Tube Cutters**

Lagonda Mfg. Co., Detroit, Mich.

**Tubing**

National Tube Co., Pittsburg, Pa.

**Tubing, Metallic**

Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa;

**Turbines, Steam**

De Laval Steam Turbine Co., Trenton, N. J.
General Elec. Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.
Wing Mfg. Co., L. J., New York.

**Unions**

Bard Union Co., Norwich, Conn.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Dart Mfg. Co., E. M., Providence, R. I.
Jefferson Union Co., Lexington, Mass.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, O.

**Unions**—*Continued.*

Williams Valve Co., D. T., Cincinnati, Ohio.

**Valve Balls**

Diamond Rubber Co., Akron, Ohio.

**Valve Discs**

Allan & Son, A., New York.
Diamond Rubber Co., Akron, Ohio.
Mechanical Rubber Co., Cleveland, O.

**Valve Reseating Machine**

Leavitt Machine Co., Orange, Mass.

**Valve Seat Planing Machine**

Underwood & Co., H. B., Philadelphia, Pa.

**Valves**

Crane Co., Chicago, Ill.
Liberty Mfg. Co., Pittsburg, Pa.
National Tube Co., Pittsburg, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Ohio Brass Co., Mansfield, O.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Ammonia**

York Mfg. Co., York, Pa.

**Valves, Angle**

New Bedford Boiler & Mach. Co., New Bedford, Mass.

**Valves, Automatic**

Lagonda Mfg. Co., Springfield, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Webster & Co., Warren, Camden, N. J.

**Valves, Back Pressure**

Schutte & Koerting Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

**Valves, Balance**

Mason Regulator Co., Boston, Mass.

**Valves, Blow-off**

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Homestead Valve Mfg. Co., Pittsburg, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

**Valves, Boiler Stop**

Davis Regulator Co., G. M., Chicago, Ill.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

**Valves, By-pass**

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co., Boston, Mass.

**Valves, Check**

Greene, Tweed & Co., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co, Troy, N. Y.
Nelson Valve Co., Philadelphia, Pa.
Pittsburg Valve and Fittings Co., Barberton, Ohio.
Walch & Wyeth, Chicago, Ill.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Cylinder Relief**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

**Valves, Drain**

Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Electric**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Electrically Operated Trip**

Schutte & Koerting Co., Philadelphia, Pa.

**Valves, Exhaust**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Exhaust Relief**

Alberger Condenser Co., New York.
Davis Co., John, Chicago, Ill.
Walch & Wyeth, Chicago, Ill.

**Valves, Foot**

New Bedford Boiler & Mach. Co., New Bedford, Mass.

**Valves, Free Exhaust**

Schutte & Koerting Co., Philadelphia, Pa.

**Valves, Gas**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Gate**

Central Station Steam Co., Detroit, Mich.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Greene, Tweed & Co., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Nelson Valve Co., Philadelphia, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Pittsburgh Valve & Fittings Co., Barberton, Ohio.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Globe**

Detroit Lubricator Co., Detroit, Mich.
Eastwood Wire Mfg. Co., Belleville, N. J.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O'
Nelson Valve Co., Philadelphia, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Ohio Brass Co., Mansfield, O.
Pittsburgh Valve & Fittings Co., Barberton, Ohio.
Pittsburgh Valve, Fdry. and Construction Co., Pittsburg, Pa.
Powell Co., Wm., Cincinnati, O.

**Valves, Hose Gate**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Hydraulic**

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Nelson Valve Co., Philadelphia, Pa.
Schutte & Koerting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Incinerator**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Lever Gate**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Lever and Throttle**

Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co, Boston, Mass.
Powell Co., Wm., Cincinnati, O.

**Valves, Non-return**

Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

**Valves, Pneumatic**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Pop Safety**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Kunkle & Co., E. B., Fort Wayne, Ind.
Lunkenheimer Co., Cincinnati, O.
Star Brass Mfg. Co., Boston, Mass.

**Valves, Pump**

Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.

**Valves, Railroad**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Regrinding**

Nelson Valve Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Regulating**

Fisher Governor Co., Marshalltown, Iowa.
Ohio Brass Co., Mansfield, Ohio

**Valves, Relief**

Wheeler Condenser & Engineering Co., New York.

**Valves, Safety**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Kunkle & Co., E. B., Fort Wayne, Ind.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

**Valves, Safety Gate**

Walch & Wyeth, Chicago, Ill.

**Valves, Steam**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Stop Check**

Schutte & Koerting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Superheated Steam**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Swing Gate**

Walch & Wyeth, Chicago, Ill.
Williams Valve Co., D. T., Cincinnati, Ohio.

**Valves, Tank**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Water**

Nelson Valve Co., Philadelphia, Pa.

**Valves, Water Relief**

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.

**Valves & Washers, Leather**

Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.

**Ventilators**

Burt Mfg. Co., Akron, O.
Ohio Blower Co., Cleveland, O.
Wing Mfg. Co., L. J., New York.

**Vises**

Armstrong Mfg Co, Bridgeport, Conn.

**Vulcanizers**

Bigelow Co., New Haven, Conn.

**Water Columns**

Davis Co., John, Chicago, Ill.
Jerguson Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Robertson & Sons, Jas. L., New York.
Safety Equipment Mfg. Co., Chicago, Ill.
Wright Mfg. Co., Detroit, Mich.

**Water Purifiers, Feed**

Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

**Water Softening Apparatus**

Bird-Archer Co., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.
Scaife & Sons Co., Wm. B., Pittsburg, Pa.

**Whistles**

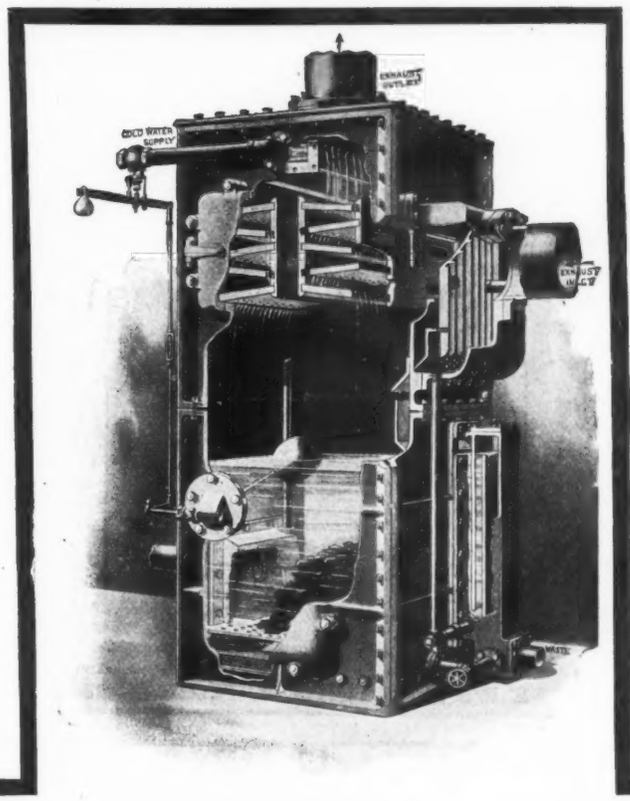
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.

**Wrenches**

Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

**Wrenches, Pipe**

Armstrong Mfg. Co., Bridgeport, Conn.
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.




# DO COCHRANE HEATERS PAY?

**A well-known cooperage concern writes us:—**

"The Cochrane Heater we purchased from you in January is doing more than we really expected it to do. Before we put this apparatus into service, we were compelled to clean our boiler once every week, and we always got from two to three bushels of mud in the cleaning. Now we sometimes let it go as long as a month, and never get more than a handful of mud. Furthermore, we bought wood for fuel, now we are selling, at the rate of $1.00 per day, offal. At this rate the wood sales will soon pay for the heater, besides it has increased our steaming facilities 25%, saying nothing of prolonging the life of the boiler."

Another customer of ours, a leather concern, wrote that they could not notice any difference in their coal bill, so we asked them to run two tests, three days with the heater in service and three days without the heater. The first test went off all right, but on the second day of the second test, their consulting engineer, who called around to keep track of the tests, found that the heater was back in service again, that they could not get along without it, and he discovered at the same time how much more coal they had to burn to get the same amount of steam from their boilers when the heater was not in operation.

In another case that came up recently, our inspector called on a large stove manufacturer who had bought a Cochrane Heater. The stove manufacturer was so highly pleased with his purchase that he said that if we would send him a second bill he would be pleased to pay the purchase price over again. The heater was returning its first cost at the rate of once every six months.

A Cochrane Heater pays big dividends on the investment because it

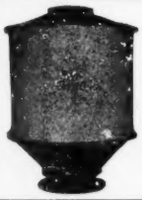
Saves coal, 10 to 16%,
Saves water, 10 to 15%,
Saves boiler cleaning,
Saves boilers or adds 16% to their capacity,
Does the work of hot well, muffle tank, skimming tank, cold water regulator, receiver pumps and independent oil separator.

Submit particulars about your plant and we shall be pleased to prepare an estimate and to advise as to lay-out.

Ask for Treatise, "15–H," on the Profitable Utilization of Exhaust Steam.

**HARRISON SAFETY BOILER WORKS,**

**17th and Clearfield Sts., PHILADELPHIA, PA.**



**That Exhaust Drizzle**

ruins your roofs and walls, is filthy and all together unnecessary. Use Sterling Exhaust Heads!

*CATALOG?*

**Economic Ventilation**

requires well designed, durable ventilators — the best designed and most durable are the Sterling.

**STERLING BLOWER AND PIPE MFG. COMPANY, 6827 First Avenue, Hartford, Conn.**

NEW YORK OFFICE, 109 LIBETY STREET.

**IN STOCK FOR PROMPT SHIPMENT.**

BOILERS.

4 72″x18′, 125 lbs. pres., "Wickes," NEW.
4 72″x16′, 125 lbs. pres., "Wickes," NEW.
1 300 H.P. "Wickes" vertical water tube.
3 200 H.P. "Geary" water tube.
1 150 H. P. "Wickes" horizontal water tube.
500 H.P. "Seabury" marine boiler.
100 H.P. "Economic" portable boiler.

ENGINES.

2 38″x72″ modern heavy duty, "Corliss," practically NEW.
30″x72″ R. H. "Corliss."
30″x60″ "Rankin & Fritsch" Corliss.
28″x60″ "Harris" Corliss. 23″x60″ "Corliss."
19″ and 38″x48″ "Allis" Corliss.
28″x56″ L. H. "Buckeye" automatic.
15″x17″ automatic vertical.

AIR COMPRESSORS.

18½″x11¼″x4″ "Ingersoll-Sergeant."
18″x18″x18″ "Laidlaw-Dunn-Gordon."
16″x15″x16″ "Straight Line."
16″x10″x10″ "Blaisdell," Class A. C.
12″x16″x14″ "Hall" Straight line.
11″ and 6″x6″ "Pedrick & Ayer," No. 1.
10″x18″x18″ "Snider-Hughes."
10″x10¼″x7½″x12″ D'Auria, duplex comp.

CONDENSERS.

1400 H.P. "Wheeler" surface condenser, with combined vacuum and circulating pump, two 12″ exhaust inlets.

DUPLEX PUMPS.

20″x8″x16″ "Canton," 6″ dis.
17″x7¾″x15″ "Worthington," 4″ dis.
16″x12″x10″ "Smith-Vaile," 7″ dis.
14″ and 20″x12″x12″ comp., 10″ dis.
14″x14″x18″ "Hughes," 10″ dis.
12″x7″x10″ "Worthington," 4″ dis.
10″x6 x14″ "Smith-Vaile," 4″ dis.
10″x6″x10″ "Canton," 4″ dis., NEW.
6″x4″x6″ "Smith-Vaile," 2″ dis.

GENERATORS, DIRECT CONNECTED TO ENGINES.

50 K.W., 110 Volt, 1000 light, Gen Elec., direct connected to 10″ and 14″x14″ "Russell" tandem comp, automatic engine.
50 K.W., 125 Volt, 1000 light, Commercial direct connected to 11″x14″ Buckeye style C., automatic engine.
16 K.W., 80 Volts, Gen. Elec. generator, direct connected to 8½″x6″ double, vertical automatic engine.
15 K.W., 125 Volts, 300 light, Westinghouse direct connected to 7½″x10″ L. H. auto. engine.

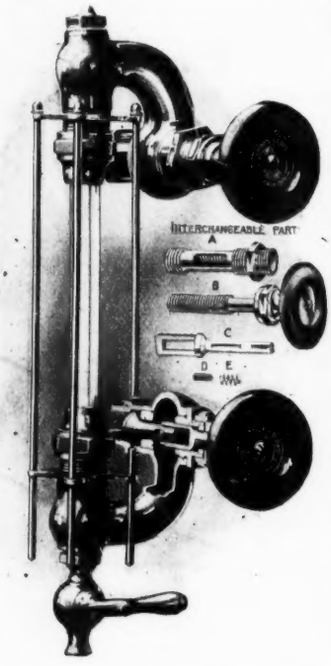
DIRECT CURRENT GENERATORS.

100 K.W., 250 V., 2000 Lt., "Milwaukee."
80 K.W., 125 V., 1600 Lt., "Westinghouse."
40 K.W., 125 V., 800 Lt., "Detroit" bipolar.
30 K.W., 220 V., "Fort Wayne."
27½ K.W., 110 Volt, 550 Lt., four-pole.
16½ K.W., 110 V., 3330 Lt., "Rockford."
15 K.W., 110 V., 200 Lt., "Thompson."
100 H.P., 500 Volt., "Westinghouse," D.C. Motor.

Send for monthly stock lists of refitted machinery and power equipment. Prompt shipment of all items listed.

**WICKES BROTHERS, Saginaw, Mich. New York. Pittsburg.**

## Stulp Automatic Safety Water Gauge




Awarded Medal and Diploma at Jamestown Exposition.

The Stulp Gauge automatically grinds its own valve seats and cleans its way to the boiler. It means less leaky flues and longer life for boiler, full protection to men and less money spent in litigation.

Approved—The Stulp Automatic Safety Water Gauge was approved by the U. S. Board of Supervising Inspectors of Steam Vessels at their annual meeting at Washington, D. C., January and February, 1907, and allowed to be used on all boilers coming under the jurisdiction of the Steamboat Inspection Service, *and now in use by the U. S. Government as well as the largest power plants, steamship and transportation companies in the country.*

Write for Catalog and Testimonials.

**The Automatic Safety Water Gauge Co.,**

Fred J. Stulp, Prop.

MUSKEGON, MICH.

1876-1908

## The Fidelity and Casualty Co.

of New York.

George F. Seward, President. Robert J. Hillas, Vice-President and Secretary.

The company grants insurance as follows:

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|---|---|
| FIDELITY BONDS | STEAM BOILER |
| EMPLOYERS' LIABILITY | ELEVATOR |
| PERSONAL ACCIDENT | FLY WHEEL |
| HEALTH | BURGLARY |

PLATE GLASS

In the Fidelity, Boiler, Elevator, and Fly Wheel Lines careful inspections are made by experts.

| Capital: | Assets: | Surplus: |
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| $1,000,000. | $8,073,144.13. | $1,536,189.88. |

## Compare Old Results With New

and you will discover new ways to improve.

This indicator furnishes permanent daily and hourly records.

This meter is also adapted to the measurement of water, of air, and other gases.

*Details?*

**G. C. ST. JOHN**
**140 Cedar Street**
**NEW YORK**

The St. John Indicating and Recording Steam Meter

## A FREE COPY OF BOOKLET "A" FOR YOU

Booklet "A" describes Tulley's Handbook. It shows some of the illustrations given in that remarkable guide for engineers and gives the table of contents, etc. Booklet "A" is well worth having and will be sent FREE to you. Ask us to send you booklet "A."

**HILL PUBLISHING CO., 505 Pearl St., New York City**

# Cling-Surface Co

1032-1048 Niagara Street

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TELEPHONES
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August 20,1908.

The Hill Publishing Company,

New York,N.Y.

Gentlemen:-

As you perhaps know, we have never favored weekly publications as advertising propositions, and when "Power" was first made a weekly we carried only a monthly advertisement.

Since,however, you have combined with the"Engineer" we have carried a weekly advertisement, and we have pleasure in now advising you that for the months of April, May, June and July we have received six times as many inquiries from our advertisement in "Power" as we did for the same months in 1907.

The advertisements are the same alternate half and quarter pages simply appearing more often.

This instance has not convinced us that weekly publications are, as a rule, better than monthly because you have had a new and unusual proposition, but aside from our opinion, we thought that perhaps you might be interested to know the actual results.

With best wishes,we are,

Yours very truly,

CLING-SURFACE COMPANY

Wm. D Young

W.D.Y.-B. Secretary.

# The Largest Contract Ever Awarded

for steam pipe and boiler coverings was awarded by the experts of the Manhattan Railway Company of New York and specified

## Carey's 85% Magnesia Pipe Covering

These coverings are used almost exclusively by the U. S. Government and in big plants where purchases are passed upon by expert engineers.

Uncovered or poorly covered pipes are a source of endless expense due to condensation, consequent loss of steam and damages to engine cylinders.

Carey's Coverings repay their cost every 6 or 8 months.

*CATALOG?*

**The Philip Carey Company,**

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**Factories:**
**Lockland, O.**
**Plymouth Meeting, Pa.**
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BRANCHES and Warerooms:

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Baltimore, Md., 434-438 N. Holliday St.
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Chattanooga, Tenn., 10th & Baldwin Sts.
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Detroit, Mich., 17 Jefferson St.
Denver, Colo., 1717 Wazee St.
Havana, Cuba, Obrapia No. 55.
Jacksonville, Fla., 414 E. Bay St.
Kansas City, Mo., 526 Delaware St.
Knoxville, Tenn., Hume St. & South'n R. R.
Little Rock, Ark., 418-420 E. Markham St.
Memphis, Tenn., 168-172 So. Second St.
Montreal, Que., Can., 8-10 Youville Place.
Nashville, Tenn., 170 2nd Ave., N.
Newark, N. J., 49-51 Bank St.
New Orleans, La., 222 Chartres St.
New York, N. Y., 114-118 Liberty St.
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Pittsburg, Pa., 333-335 Second Ave., and 1472 Frick B dg. Annex.
Richmond, Va., 1585 E. Main St.
Seattle, Wash., 2005 Second Ave.
St. Louis, Mo., 918-920 No. 2nd St.
Scranton, Pa., Traders Bank Bldg.
Toledo, O., 120 Summit St.
Toronto, Can., 112 Bay St.
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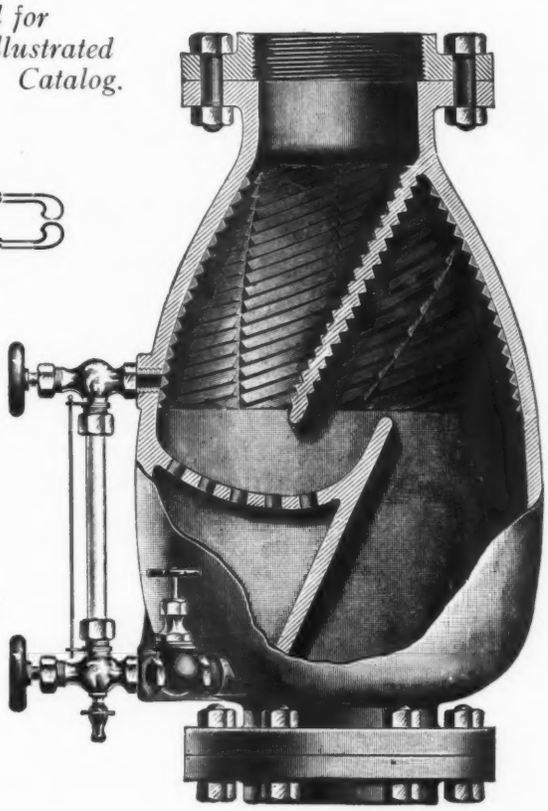
*Send for Illustrated Catalog.*



# THE AUSTIN
# Figure "A" Vertical
## IRON
## STEAM SEPARATOR

Separates the moisture and "slugs" of water from the steam current before it reaches the engine.
Delivers DRY STEAM to the engine cylinders with all its well known efficiency and safety as compared with the weakness and danger of cylinder explosions incidental to the use of wet steam.
We ship subject to trial and return at our expense if results are unsatisfactory.

**AUSTIN SEPARATOR CO.**
**DETROIT, MICH. 57 Woodbridge St.**

## Get the Full Value of Your Steam

by separating all the condensation before it reaches the engine.

**Gardner Separators**

considerably reduce the cost of operation, give greater power and longer wear. Write.

**The Gardner Governor and Separator Co.**
**Quincy, Illinois.**

## A Money back Proposition

After a 30 days' trial—if you are not convinced that the Baum Separator will prove a profitable investment we will return your money and pay for returning the separator.

**Send for new Catalogue and prices.**

**HERSHEY MACHINE & FOUNDRY CO.**
**MANHEIM, PA., U. S. A.**

W. G. Ruggles Co., 54 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.

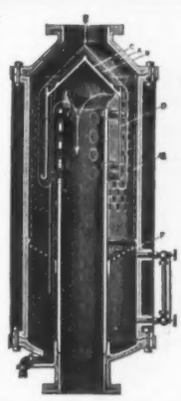
**50% Of All Sweet's Separators In Use Sold On Repeat Orders**

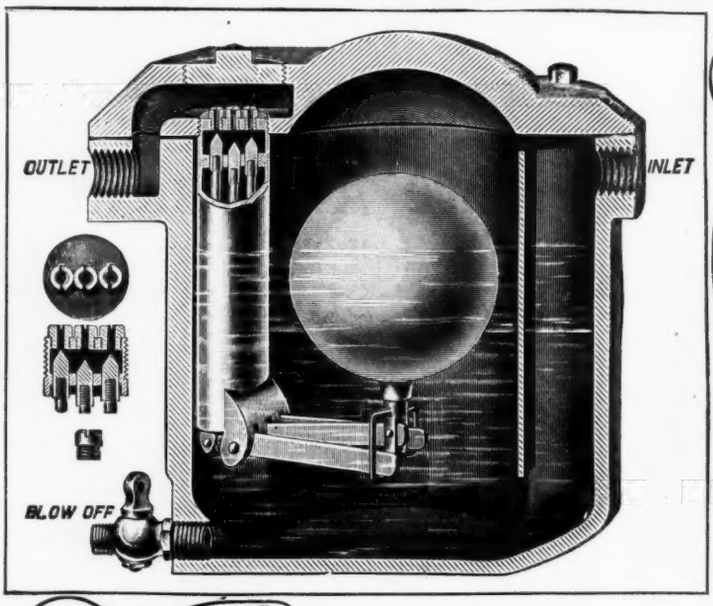
# 3,000 ON REPEAT ORDERS

show that those who try Sweet's Separators are satisfied. Can we offer any higher proof of their efficiency, convenience and durability? They deliver steam 99.8% dry and extract 99% of the oil.

*Ask for Descriptive Catalog.*

**DIRECT SEPARATOR CO.,**
**712 GEDDES STREET, SYRACUSE, N. Y.**






The
# Wright "Emergency"
High Pressure
Continual Flow
# Steam Trap

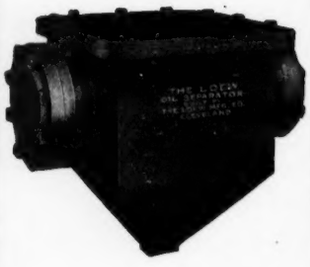
**For the Automatic Drainage of Accumulating Condensation from Steam Systems.**

THREE VALVES in the "EMERGENCY" Trap insure great capacity together with equal efficiency in discharging the smallest flow or floods of condensation without the waste of a pound of steam.

We ship subject to thirty days trial and return at our expense if results are unsatisfactory. Send for catalog.

## WRIGHT MANUFACTURING CO.

DETROIT, MICH. 27 WOODBRIDGE ST.



# LOEW SEPARATORS
## Steam and Oil

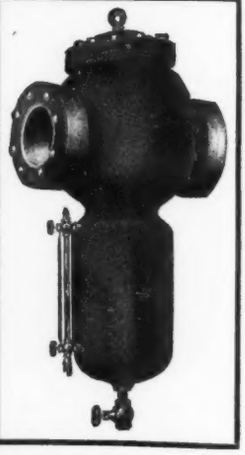
**Guarantee the Highest Efficiency and Greatest Economy**

The Steam Separator insures dry steam to the cylinders and prevents engine troubles; reduces fuel bills and adds to the efficiency of the engine.

The Oil Separator is self-cleaning and will not clog. Original efficiency retained indefinitely.

*SEND FOR CATALOGS.*

**THE LOEW MANUFACTURING CO., . . . . CLEVELAND, OHIO.**



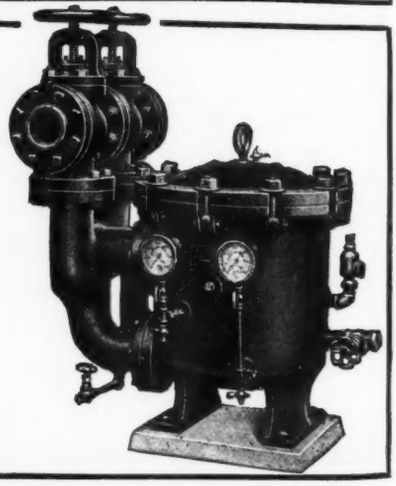
# "Giving Entire Satisfaction"

The above written by a leading lumber plant voices a common sentiment concerning the

**Blackburn-Smith Feed Water Filter and Grease Extractor**

This device offers the most logical method of removing mud and slime from the water supply and for extracting oil, greases and dirt from the condensation. Our system of double filtration through small terry covered cartridges makes good under the most severe conditions.

Write for booklet "Feed Water Filtration."

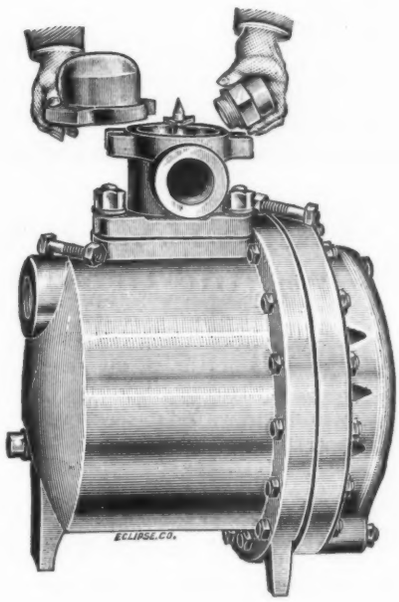


**JAMES BEGGS & CO.**
**109 Liberty St., New York City**

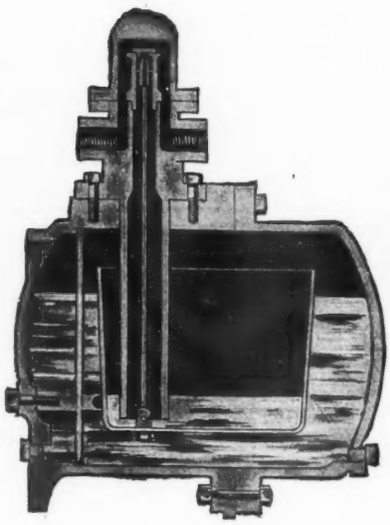
# 4/S STEAM=TRAPS 4/S

**JUST SEE HOW EASY IT IS TO INSPECT THE VALVE AND SEAT.**

**No Trouble At All, Remove 2 Bolts Lift Off the Cap And the Valve is Before You**



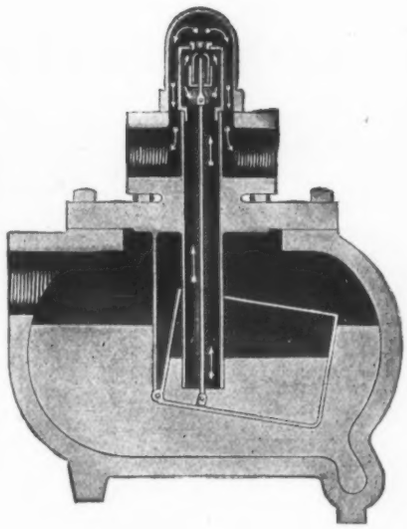

**No Piping to Disconnect No Stunts to Perform To Remove or Replace Troublesome Valves**



Simple mechanical construction. Open cast-iron bucket connected by a straight rod attached to the valve is all the working parts in our traps —just enough to do the work and we guarantee satisfactory results.

Sizes ½ to 3 inches.

Capacities equal to any condition.



*Our Catalog A gives a full description of our traps, etc. May we send you one?*

## The Strong, Carlisle & Hammond Co.

**342 Frankfort Ave., Cleveland, Ohio.**

88 BROAD ST., BOSTON. 54 NO. 6TH ST., PHILADELPHIA. 261 CENTRE ST., NEW YORK.

Anderson's Improved Steam Trap

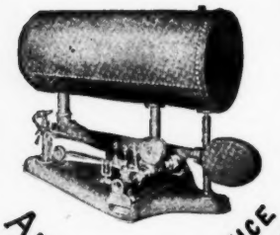
## The Water Must, the Steam Cannot Escape

This trap is so thoroughly automatic that it rarely requires any attention after it is once set in the line. But should it become necessary to inspect or repair any working part the trap can practically be turned inside out without breaking pipe connections.

*Write for our "Trap Book"*

**The V. D. Anderson Company**
1935 W. 96th Street. Cleveland, Ohio

MOREHEAD



ALWAYS IN SERVICE

## Gravity Does The Work
### And Gravity Never Fails

One end of the tank is supported only by counterweights and when the water reaches a certain level the counterweight can not hold it. Its fall opens the discharge valve and the water passes out till only a few inches are left to act as a seal and prevent loss of steam. *Write for our catalog.*

**Morehead Manufacturing Co.,**
1051 Grand River Ave. DETROIT, MICH.

## Always on Duty

The Reliance Trap

Capacious
Efficient
Durable

When you have set this trap in your system your trap troubles are at an end. *Catalog?*

**The Reliance Gauge Column Co.,**
75 E. Prospect St., Cleveland, O., U. S. A.

## FLINN DIFFERENTIAL STEAM TRAPS

*Save their Cost by Increasing Engine Efficiency.*

THE EDWARD P. ALLIS COMPANY, Milwaukee, Wis.
[AFTER SELLING OVER 500 FLINN TRAPS.]

Replying to yours of the 17th inst., we would say that we have used the FLINN DIFFERENTIAL STEAM TRAP for a number of years, practically since its first introduction, and have found it the most general satisfactory trap we have ever used.

Yours, truly,
[Signed] THE EDWARD P. ALLIS COMPANY,
*DESCRIPTIVE CIRCULAR ON REQUEST.* By Irving H. Reynolds.

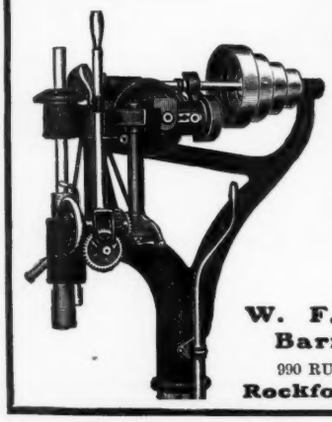
**RICHARD J. FLINN, West Roxbury Station, Boston, Mass.**

## AVOID THE DANGERS
### OF GREASE BEARING STEAM

and while you are getting a grease extractor why not get a Peerless of *guaranteed efficiency.*

BOOKLET ?

**Hussey, McCann & Co., 87 Warren St., New York**



## The BARNES Positive Feed DRILLS

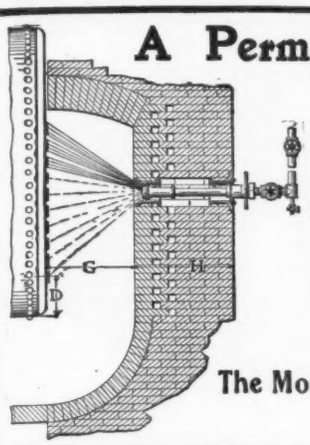
**8 to 50" Swing**

Our positive Feed means 15 to 25 per cent. increase in output of work.

*Send for Catalog.*

**W. F. & John Barnes Co.,**
990 RUBY STREET,
**Rockford, Illinois.**

TRADE MARK




## A Permanent Fixture

always ready for work is the

**MONARCH STEAM FLUE BLOWER**

It is set in the rear wall of the boiler and blows the soot out of the tubes in the direction of the natural draft.

Your fireman can easily clean the tube three or four times a day, as it takes but five minutes.

*WRITE!*

**The Monarch Steam Blower Co.**

Troy, New York

# Nason Steam Traps

**"SIDELUG" TRAP**
(Patented)

**THE STANDARD FOR SIXTY YEARS!**

Adapted for all conditions requiring the removal of condensation without loss of steam.

**SPECIFY:**

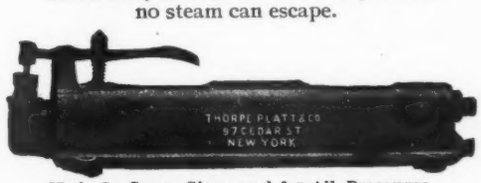
"CLASS B"—For pressures under 20 lbs.
"CLASS C"—For pressures between 20 and 70 lbs.
"SIDELUG"—For pressures higher than 40 to 150 lbs.

*Send for Catalog.*

**NASON MFG. CO., NEW YORK.**

# ON GUARD!

The **GEIPEL STEAM TRAP,** being automatic, is ever on the alert, hence no steam can escape.

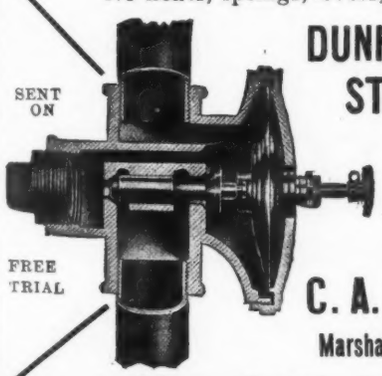



Made In Seven Sizes and for All Pressures.

*WRITE FOR CIRCULARS.*

**JOHN PLATT & COMPANY**
**97 Cedar Street NEW YORK**

No floats, springs, levers, pots or buckets the



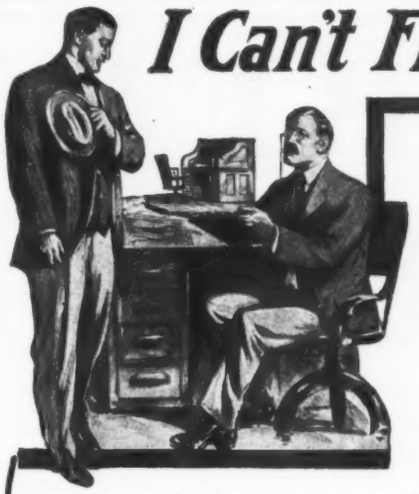

**DUNHAM SPECIAL STEAM TRAP**

operates by the power of an expanding volatile fluid. Get our Catalog "A" for description.

**C. A. DUNHAM CO.**
**Marshalltown, Iowa, U. S. A.**

Chicago Cleveland Toronto Philadelphia

# I Can't Fill It



If a good position were offered **you** today, would you have to "turn it down" because you lack the necessary qualifications? Even if you accepted the position, could you hold it—or would your lack of training compel you to step out in favor of a **better** trained man?

How can you expect a successful career unless you build it on a good foundation? **Utilize your spare moments—study at home—**fit yourself **properly** to meet opportunity—then you will succeed. The American School of Correspondence will tell you how if you'll clip the coupon and mail it **today.**

## SPECIAL HELP TO ENGINEERS

The AMERICAN SCHOOL OF CORRESPONDENCE has given hundreds of Stationary Engineers and Firemen, Oilers, Electrical Engineers, Draftsmen, Heating and Ventilating Engineers, and Plumbers just the special training which they needed to qualify for lucrative positions. Our courses in Stationary Engineering, Electrical Engineering, Locomotive Engineering, Drafting, Heating, Ventilating and Plumbing are as complete and practical as they can be made. Besides giving the most comprehensive instruction in the usual work, we teach the construction of **boilers and engines.** We give special attention to shop drawing and machine design.

**We employ no agents.** We talk to you only by mail. The money you pay is not used to maintain an expensive organization of high-priced agents, but is used to give you the **best** instruction at the **lowest** cost.

**The American School of Correspondence** is the only correspondence school in the country which makes a **specialty** of engineering instruction. Its instructors are practical men—men who have had years of actual experience in their special fields. Consult these experienced men—get their advice—profit by their years of hard experience. Let them help you plan a **paying** career. *Remember,* **sending the coupon places you under no obligations.**

## American School of Correspondence
**Chicago**

.....**COUPON**—Clip and mail today.....

Power, 9-1-08.

**American School of Correspondence:**

Please tell me how I can fit myself to earn a good salary in the line of work marked "X."

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| —Special Engineer's Course (Preparatory to License Examinations) | —Contractor and Builder |
| —Steam Engineer | —Surveyor |
| —Resident Engineer | —Telephone Engineer |
| —Heating and Ventilating Engineer | —Hydraulic Engineer |
| —Electrical Engineer | —Irrigation Engineer |
| —Boiler and Sheet Metal Pattern Draftsman | —Mechanical Engineer |
| —Civil Engineer | —Superintendent of Construction |
| —Architect | —Pattern Draftsman |
| —Architectural Draftsman | —Structural Draftsman |
| | —City Engineer |
| | —Bridge Engineer |
| | —College Preparatory Course |

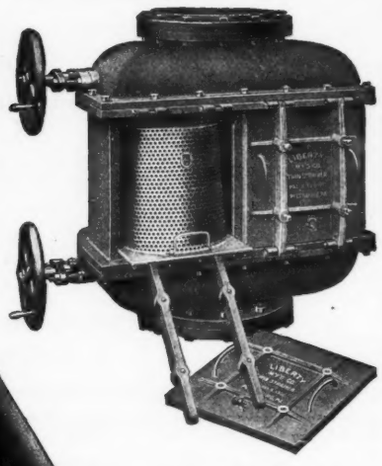
Name.....

Address.....

Occupation.....

# LIBERTY

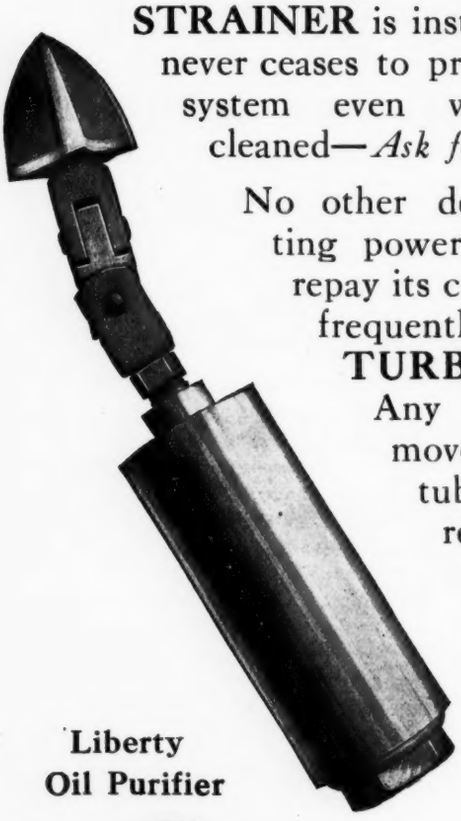
## Lightens The Power Plant Expense



Liberty
Twin Strainer

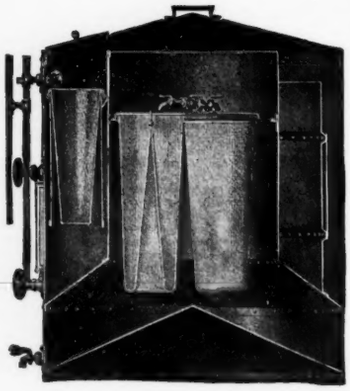
Freedom from stopped-up pressure or suction lines is an accomplished fact just as soon as the **LIBERTY TWIN STRAINER** is installed. It never ceases to protect your system even when being cleaned—*Ask for particulars.*

No other device, for cutting power-plant costs, will repay its cost so surely and so frequently as the **LIBERTY TURBINE CLEANER.** Any thickness of scale removed without injury to the tubes and in half the time required by other cleaners. *Catalog ?*



Liberty
Oil Purifier

Why strain oil when it is just as easy and much more satisfactory to refine it ? The **LIBERTY OIL PURIFIER** is an oil refinery on a small scale and is far superior to the washers and filters which cost about the same. *Write.*

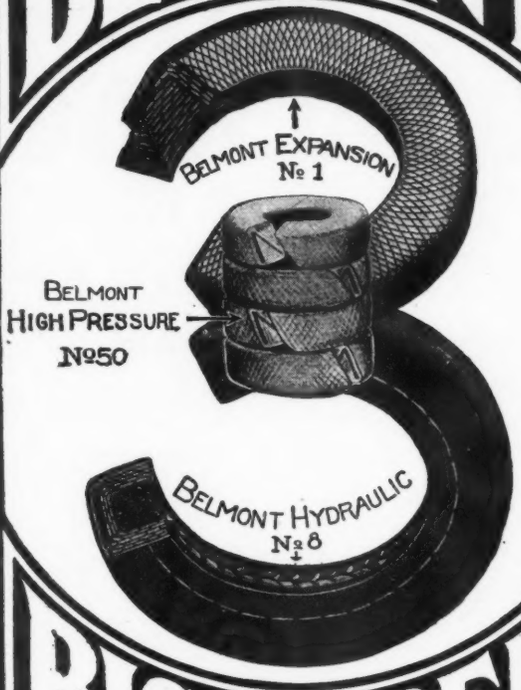


**LIBERTY MFG. CO.,**

**6509 Susquehanna St.,**

**PITTSBURG, - - PA.**

# BELMONT




# BIG THREE

Three good friends needed by every engineer are.

**BELMONT "1903" EXPANSION PACKING, Style No. 1,** with three break joints, which, when joined, makes practically a solid ring. For shallow stuffing boxes this packing cannot be equaled, as a single ring will prevent escape of steam. Especially suitable for **ammonia** and **steam** up to 125 lbs. pressure. Write for booklet A.

**BELMONT HIGH PRESSURE WEDGE PACKING, Style No. 50,** composed of two asbestos sliding wedges from which all metallic particles have been removed by the magnetic process, and a back containing a rubber compound which is absolutely unaffected by highest steam pressures. Lubricated by best special high test lubricating compound, in connection with best graphite. The only safe packing for **high pressure** or **superheated steam.** Write for booklet B.

**BELMONT "1903" SPECIAL HYDRAULIC PACKING, Style No. 8,** (for hot or cold water), consists of a casing of finest cotton duck and rubber, around three sides of a braided flax core. This packing is stitched through and through crosswise, hence, cannot be twisted out of shape—cannot pinch or swell. For any kind of pumping service, but on the **water end only, not for steam.** Unaffected by alkalis, oils or sulphuric acid mine water. Write for booklet C.

We manufacture packings for every known purpose. General catalog free on request.

## FREE

Sample Ring of either of these three packings free. Fill in coupon with name of kind wanted.

**FREE! SEND FOR A SAMPLE RING AND BE CONVINCED.**

CLEMENT RESTEIN CO., Philadelphia, Pa.
Gentlemen:—Send me a sample ring of.....
.....
Name.....
Address.....
Firm Name.....
Number of Engines.....
Number of Pumps.....
Number of Boilers.....
High or Low Pressure.....
Packing Now in use.....

Power, Sept. 01.

**CLEMENT RESTEIN CO.**
**133 North Second Street, PHILADELPHIA, PA.**

SALESMEN WANTED.
To call at power plants, pumping stations and engine rooms, and sell BELMONT PACKINGS and Specialties. Particularly attractive proposition for manufacturers, agents and engineers in territory not already covered. CLEMENT RESTEIN CO., 133 North Second Street, Philadelphia, Pa.

# We're Going to Raise Your Salary

**"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."**

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

**INTERNATIONAL CORRESPONDENCE SCHOOLS**
**Box 979, Scranton, Pa.**

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked X.

| | | |
|---|---|---|
| Electrical Engineer | Machine Designer | Sanitary Engineer |
| Elec.-Lighting Supt. | Mechanical Draft. | Architect |
| Elec.-Railway Supt. | Foreman Machinist | Architectural Draft. |
| Electrician | Foreman Toolmaker | Ad Writer |
| Telephone Engineer | Foreman Molder | Window Dresser |
| Civil Engineer | Foreman Blacksmith | Chemist |
| Bridge Engineer | Marine Engineer | Sheet-Metal Draft. |
| Mechanical Engineer | Hydraulic Engineer | Ornamental Design. |
| Stationary Engineer | Municipal Engineer | Textile Designer |
| Gas Engineer | R. R. Construc. Eng | Bookkeeping |
| Refrigeration Eng. | Surveyor | Stenographer |
| Traction Engineer | Mining Engineer | Civil Service Exams. |

*Name* _____

*St. and No.* _____

*City* _____ *State* _____

# PEERLESS SPIRAL PISTON AND VALVE ROD PACKING

IS THE MOST SATISFACTORY PACKING IN THE WORLD.
IT WILL RUN FROM 12 TO 16 MONTHS WITHOUT REPACKING.
WILL HOLD 400 POUNDS OF STEAM.
IT WILL PACK TIGHTLY ANY ROD HOWEVER BADLY SCORED AND CORRODED.
WILL NOT GET HARD UNDER ANY DEGREE OF HEAT.

SOLE MANUFACTURERS OF THE CELEBRATED
RAINBOW PACKING

PATENTED MANUFACTURED EXCLUSIVELY BY

## THE PEERLESS RUBBER MANUFACTURING COMPANY

## 16 WARREN ST., NEW YORK

DETROIT, MICH.-16-24 WOODWARD AVE.
CHICAGO, ILL.-202-210 SO. WATER ST.
PITTSBURG, PA.-425-427 FIRST AVE.
SAN FRANCISCO, CAL. 131 153 KANSAS ST.
NEW ORLEANS, LA: COR. COMMON & TCHOUPITOULAS STS.
ATLANTA GA.-7-9 SOUTH BROAD ST.
KANSAS CITY, MO.-1221-1223 UNION AVE.

LONDON E.C., ENGLAND.-58 HOLBORN VIADUCT
PARIS FRANCE.-76 AVE DE LA REPUBLIQUE.

SEATTLE, WASH.-RAILROADWAY & OCCIDENTAL AVE.
LOUISEVILLE, KY-111-121 W. MAIN ST.
INDIANAPOLIS, IND-16-18 SQ. CAPITOL AVE
OMAHA. NEB.-12 18 FARNAM ST.
DENVER, COL.-1723-1731 BLAKE ST.
RICHMOND. VA,-COR. NINTH & CAREY STS.
WACO, TEXAS-709-711-AUSTIN AVE.

**FOREIGN DEPOTS**

SYDNEY, AUSTRALIA,-270 GEORGE ST.
JOHANNESBURG, SOUTH AFRICA:-2427 MERCANTILE BL'D'G

BOSTON, MASS.-110 FEDERAL ST.
BUFFALO, 379-383 WASHINGTON ST.
MILWAUKEE, WIS. 96-100 SECOND ST.
SYRACUSE, N.Y.-212-214 SO. CLINTON ST.
LOS ANGELES, CAL-115 SO. LOS ANGELES ST.
PORTLAND, ORE.-14-16 FIRST ST.
BALTIMORE, MD.-37 HOPKINS PLACE.

COPENHAGEN. DEN-FREDERIKSHOLMS KANAL 6.
VANCOUVER, B.C-CARRAL & ALEXANDER STS.

TRADE MARK MARCO REG. IN U.S. PAT. OFF. PACKINGS

TRADE MARK MARCO REG. IN U.S. PAT. OFF. PACKINGS

*Gentlemen:—*

THERE are hundreds of packings.
There are many good packings.
There are many manufacturers of packings.
There are lots of keen hustling salesmen.
We welcome keen competition.
We have a welcome hand to all.
We take pleasure in a friendly tussle.
We have confidence in the results.
Because we make our packings carefully.
Because we use the best of materials.
Because our men are practical.
Because everything is thoroughly inspected.
Because making packing is not a side line.
It is a specialty with us.
We answer all inquiries courteously.
We take pains to answer them promptly.
May we not hear from you?

THE CLEVELAND RUBBER WORKS
*of The Mechanical Rubber Co.*
No. 68 Lisbon Road, CLEVELAND, OHIO

TRADE MARK MARCO REG. IN U.S. PAT. OFF. PACKINGS

D-1

TRADE MARK MARCO REG. IN U.S. PAT. OFF. PACKINGS

# Cobbs High Pressure Spiral Piston and Valve Stem Packing

The Rubber core is made of an oil and heat resisting compound, wrapped with a well frictioned Duck, with an outer cover of fine asbestos, lubricated by our secret process.

It is made round or square, in coil or spiral form especially adapted to withstand heat and high pressure. We guarantee "Cobbs" Packing will pack any rod perfectly tight, as it will not get hard under any degree of heat.

"Cobbs" Packing also furnished in rings at short notice, made of round or square packing.

## Indestructible White Sheet Packing

Is without doubt the toughest and most durable High Pressure Sheet Packing on the market. It will stand the highest pressure and extreme heat, making a tight joint when used for Steam, Air, Hot or Cold Water.

It does not dry out or become hard and brittle, but retains its tough elastic qualities, either in or out of service. Ammonia, Liquor, Alkali, Oils or Acids have little or no effect on it, and joints can be broken numerous times without renewing the packing.

Indestructible White Sheet Packing is also made with wire insertion.

We manufacture a complete line of high class rubber goods, comprising Belting, Air, Fire, Garden, Steam, Suction, Pneumatic Tool and Water Hose Packings, Gaskets, Mats, Matting, Stopples, Special Mould Goods, Interlocking Rubber Tiling, Tubing, etc.

SOLE MANUFACTURERS

## New York Belting & Packing Company, Ltd.

**91 and 93 Chambers Street, New York, N. Y.**

CHICAGO, 150 Lake St.
ST LOUIS, 218-220 Chestnut St.
PHILADELPHIA, 118-120 N. 8th St.
SAN FRANCISCO, East 11th St and 3d Ave., OAKLAND.
BOSTON, 232 Summer St.
INDIANAPOLIS, 229 S. Meridian St.
BALTIMORE, 114 W. Baltimore St.
BUFFALO, 600 Prudential Bldg.
PITTSBURG, 913 915 Liberty Ave.
SPOKANE, WASH., 163 S. Lincoln St.
LONDON, E. C., ENGLAND, 58 Holborn Viaduct.

# Eureka

## Packing Is Not Lacking In Backing

It is used all over the world because it saves time, money and trouble. For worn or scored rods Eureka has absolutely no equal, and users proclaim that.

## It's Quality Sets The Standard

No packing can be more effective or more durable—yet Eureka costs one-third less than any other first-class brand.

We also make high grade Cut Ring, High Pressure, Water Proof Hydraulic in rings and coils, Spiral and Red Sheet Packings. Samples and prices furnished.

*Ask your dealer for Genuine Eureka.*

**Be Sure You Get**

THIS LABEL ON PACKING "EUREKA" TRADE MARK. IS A GUARANTEE OF EXCELLENCE.

**Genuine Eureka**

## Eureka Packing Company,

**Sales Department,**

**Jas. L. Robertson, Pres't** **46 Warren St., New York.**

**An Engine Necessity**

**THE ROBERTSON-THOMPSON INDICATOR**

and Victor Reducing Wheel furnish the information an engineer needs to fit himself for a better position. The price is easy enough for any one. The WILLIS PLANIMETER is superior to all others. Details?

## Jas. L. Robertson & Sons,

**46 Warren St., New York.**

HOME RUBBER CO. TRENTON, N. J.
STEAM
NEVER BURN BLOW OUT.
PACKING.
TRADE MARK
CHICAGO NEW YORK

# N. B. O.
## Solves the Packing Problem

**O. I. M.**
**on its merit**

**Low Pressure**
Use where pressure does not exceed 100 lbs.

It is made of the best materials in generous quantities and so assembled that it never can be blown, burned, squeezed, or rotted out. Look for the trade-mark.

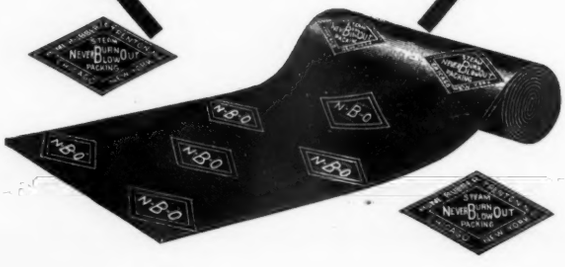
## O. I. M. PACKING

fits uneven surfaces on scored or uneven rods because the diagonal cut provides a kind of automatic adjustment. The low pressure has an absorbent cushion, the high pressure an elastic hard friction tuck. Write.

**O. I. M.**
**on its merit**

**High Pressure**
Use where pressure is above 100 lbs.

**Home Rubber Company,**
**Woolverton Ave., TRENTON, N. J.**
New York, 80 and 82 Reade St.
Chicago, 54-60 S. Canal St.
London—Balfour House, Finsbury Pavement.



# THE UP-TO-DATE ENGINEER ANCHORS TO

# Because

"THURIL" is a High Pressure Sheet, equally well adapted for superheated steam, motor or gas engine joints, ammonia, chemicals, hot and cold water.

"THURIL" joints once made are finished—do not require following up, as it does not contract or burn under any conditions.

"THURIL" has a tensile strength of over three (3) tons per square inch.

"THURIL" can be used repeatedly, as often as forty times—this cannot be done with any other sheet.

"THURIL" is the only sheet packing used over the entire civilized world. We have duplicate orders and testimonials from all quarters of the earth. Can this be shown by any other packing?

"THURIL" stands ready to prove all of the above assertions. Why not give us an opportunity to do so?

"THURIL" can be bought only from the Anchor Packing Company, Head Office, Philadelphia, their branches, or authorized agents—having the sole patent rights for this material for the United States.

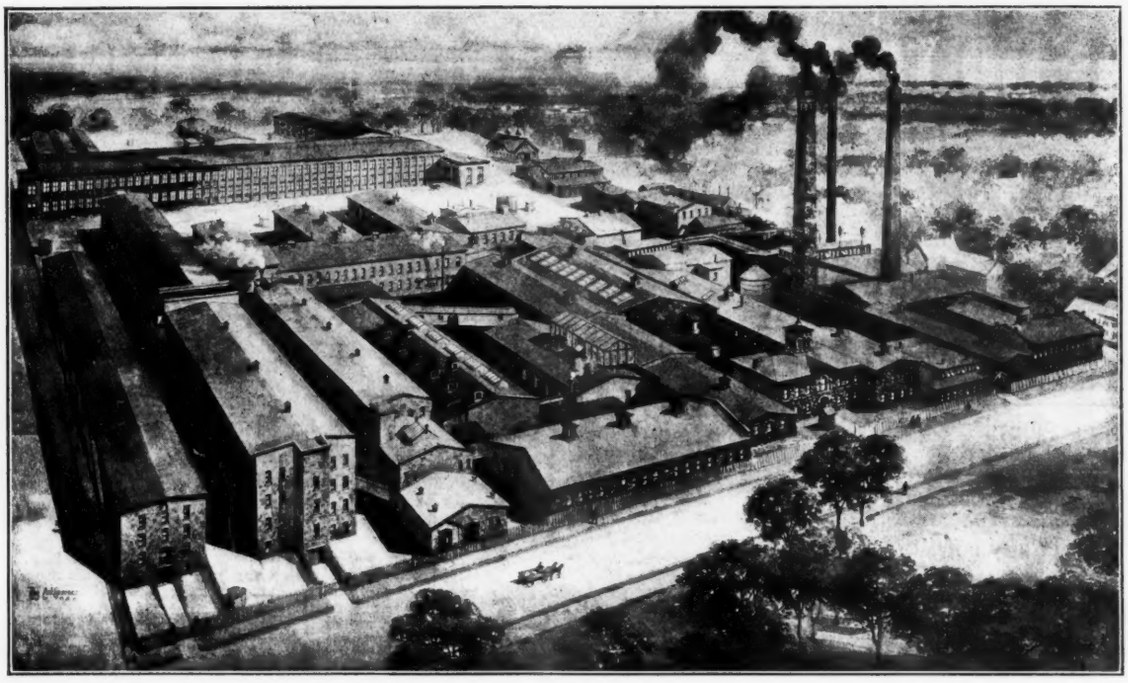
# The Anchor Packing Company,

**Main Office and Factory**

**Allegheny, Sedgely and Germantown Aves., Philadelphia, Pa.**

NEW YORK Branch, 1353 Hudson Terminal Bldg., 50 Church St.
CHICAGO Branch, 410 Railway Exchange
HAZLETON, PA., Branch, 15 North Wyoming St.
PITTSBURGH Branch, 667 Frick Bldg. Annex
BALTIMORE Branch, 514 Continental Bldg.
DETROIT Branch, Ford Bldg.

**Representatives in all Industrial Centres**



# This Is The Plant

## That Makes The

# Famous N. I. R. Packings

## For All Kinds Of Service.

N. I. R. Red Sheet is absolutely unaffected by highest temperatures and is impervious to action of gases, liquids and ammonia. Made of best grade rubber compound and finest quality asbestos fibre.

*Guaranteed to withstand highest steam pressure.*

Give N. I. R. a trial.

**Write For Details and Prices.**

# National India Rubber Co.,

## Factory: Bristol, R. I.

**BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago. 140 Essex St., Boston. 37 Hopkins Pl., Baltimore. 379 Washington St., Buffalo.**

ENGINEERS WHO HAVE USED

# INDIAN RED SHEET PACKING

Will tell you it has the

STAYING AND RESISTING QUALITIES

It is efficient in every respect
which, in the end, means economy.

A 14 x 28 hanger, like cut herewith, but in colors,
free to any engineer upon request.

## The DIAMOND RUBBER CO., AKRON, OHIO.

**Complete Diamond Stocks Carried By**

The Diamond Rubber Co. of N. Y.,
1876 Broadway, N. Y.
The Diamond Rubber Co.,
1523 Michigan Ave , Chicago, Ill.
The Diamond Rubber Co ,
Mission and 2nd Sts., San Francisco, Cal.
Buffalo Mill Supply Co.,
Buffalo, N. Y.
Southern Hardware & Supply Co.,
Mobile, Ala.
Consumers Rubber Co.,
Cleveland, Ohio.
The Diamond Rubber Co. of N. Y.,
304 N. Broad St., Philadelphia, Pa.
The Diamond Rubber Co.,
3963 Olive St., St Louis, Mo.
The Gustin-Bacon Manufacturing Co.,
Kansas City, Mo.
Pittsburgh Rubber & Leather Co.,
Pittsburgh, Pa.
Alabama Machinery & Supply Co.,
Montgomery, Ala.
M. I. Wilcox Co.,
Toledo, Ohio.

"SAŸEN-REED"

# Saÿen-Reed Asbestos Packing

**Specially adapted for High Pressure and Super-heated Steam**

The fabric is woven from strands made of brass wire and asbestos. Rubber is then forced in the interstices and vulcanized. The result is a remarkably strong, flexible and durable packing which no pressure will blow out.

## WRITE FOR FREE SAMPLE

This packing is better than others—far better—and, better still, is lower priced. We will gladly send samples FREE upon request.

## MERCER RUBBER COMPANY

**HAMILTON SQUARE - - NEW JERSEY**

BRANCH OFFICES

Philadelphia, 421 Arcade Building. New York, 250 Fulton Street. Pittsburg, 8th and Liberty Streets. Denver, 610 Exchange Building. Chicago, 40 Dearborn Street.

**WEARWELL** LEATHER PACKINGS

ALWAYS THE SAME.

Made in all sizes for Hydraulic and Compressed Air Machines.

*Write for Catalog and Samples.*

**DETROIT LEATHER SPECIALTY CO., INC.,**

**175 Beecher Avenue, Detroit, Mich.**

**Makes Tight Joints Where Others Fail.**

**Torpedo Asbestos Packing**

would not otherwise be the standard for U. S. Torpedo Boat use. Circular?

**OSGOOD SAYEN,** 421 Arcade Bldg., **Philadelphia, Pa.**

**American Asbesto-Metallic Packing.**

Perfect for high pressure. Semi-metallic, packs like fibrous packing, wears like metallic and gives more satisfaction than either. Ask us just how it is made, or, better yet, get a sample and see for yourself.

**American Steam Packing Company,**

51 High Street, Boston, Mass., U. S. A.

ELEPHANT BRAND

DELTA

REG. U. S. PAT. OFF.

**THE PHOSPHOR BRONZE SMELTING CO., Limited.**

2200 WASHINGTON AVENUE, PHILADELPHIA, PA.

ELEPHANT BRAND "Phosphor Bronze"

INGOTS, CASTINGS, WIRE, RODS, SHEETS, Etc.

— DELTA METAL —

CASTINGS, STAMPINGS AND FORGINGS

ORIGINAL AND SOLE MAKERS IN THE U. S.

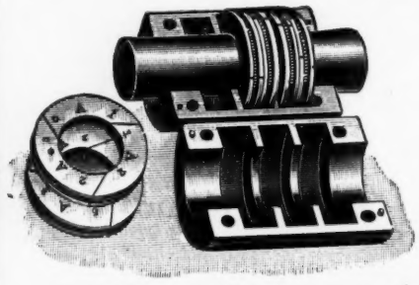
The Improved

**Tripp Metallic Packing**

Manufactured Solely By

**TRIPP METALLIC PACKING CO.** 74 India St. Boston, Mass.

**The Packing that Floats with the Rod**



**Bridgeport Improved Ring Packing**

is wonderfully flexible and it floats with the rod, offering very little resistance. There are no square shoulders to limit wear of rings and no open divisions of rings to let steam through, causing undue pressure of rings on rod. Give this packing a trial. Do not pay for it until you are satisfied.

**THE BRIDGEPORT METALLIC PACKING COMPANY**

628 RAILROAD AVENUE, BRIDGEPORT, CONN.

**THE PACKING WITH REAL HOLDING QUALITY**

Pat. March 15 1898

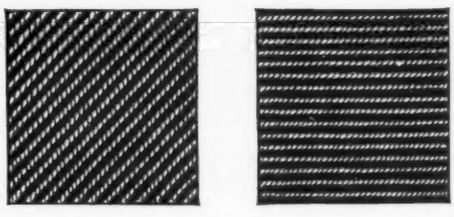
**DODS Diagonal Piston Rod Packing**

is all one piece, made from high-grade Rubber and Duck in layers placed at a diagonal from every side. This construction gives "Dods" a cross expansion of 100%. It will hold steam, air or liquids when all other packings fail.

Send for test samples and description. Address Dept. P.

CROSS-SECTIONS OF

"DODS" PACKING. ORDINARY PACKING.



☞ These Cross-Section Views Show Why!

CHICAGO **BOWERS RUBBER WORKS** SAN FRANCISCO

# ZENA

A TRIAL MEANS AN ORDER
AN ORDER MEANS A RE-ORDER

We will on request send enough packing to prove our claim that Zena has no equal for keeping rods and plungers tight with the least attention.

*WRITE*

**Randolph Brand** 72 Cortlandt Street New York

# "SAFETY"
## PLASTIC METALLIC PACKING

**For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.**

**Guaranteed to stand Steam Temperature up to 550° F. and Hydraulic Pressure to 5000 lbs. per square inch.**

**Highest Award World's Fair, St. Louis.**

Send for **FREE SAMPLE** and particulars.

MANUFACTURED BY

**STEEL MILL PACKING CO., Detroit, Mich., U.S.A.**

# PACKS EVENLY
## Even Uneven Surfaces

**Goetze's Elastic Copper Gaskets**

Stay tight for years even under the highest pressures of superheated steam.

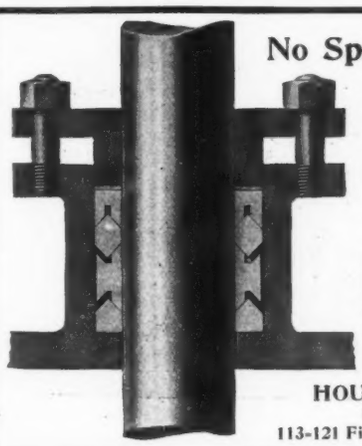
*Write for Free Samples.*

**AMERICAN GOETZE-GASKET & PACKING CO.**
**525 E. 149th St., New York City.**

# SALESMEN WANTED

In most of the large cities and supply centers, to sell the Wilcox Patented Self-Sealing Gasket, on a commission basis. We already have an established trade with a majority of the largest and best appointed plants in the United States.

**E. A. WILCOX MFG. CO., CHICAGO, ILL.**



## No Springs Required
TO KEEP
# LAW
## Metallic Packing

in place. It has a bearing on the rod with only one-half the rings, thus reducing the friction.

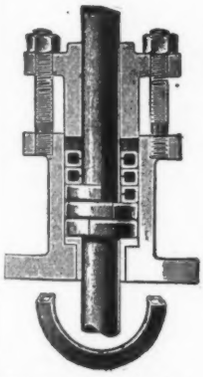
*Write.*

**HOUCHIN-AIKEN CO.**
Sole Manufacturers,
113-121 Fifty-third St., Brooklyn, N. Y.

# Mighty Good Packing

So say users of JOHNSON'S PACKINGS, MIGHTY GOOD CONCERNS use our packings too. Shall we tell you more? Remember, we let you prove things for yourself. Catalog?

**The Henry Johnson Company**
175-187 Gates Avenue Jersey City, N J.



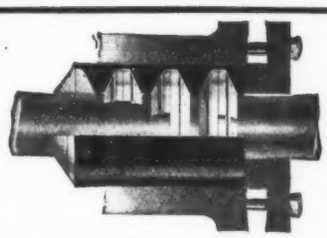
# HUHN PACKING

Huhn Metallic Packing has the endorsement of use in all the industrial countries of the world.

*Write for a sample and our booklet.*

**American Huhn Metallic Packing Co.,**
**1876 Broadway, New York.**

Operating under U. S. Patents.



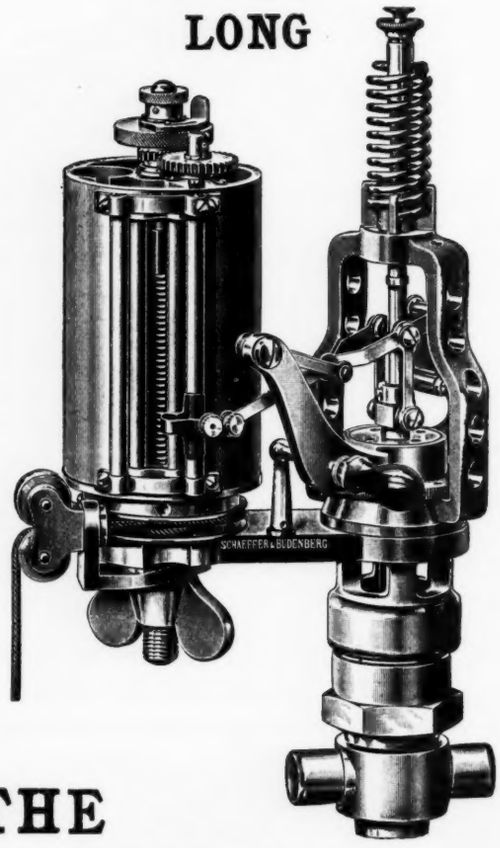
# Sterling Metallic Packing

Positively the best packing for Steam, Air, Oil and Ammonia Rods ever invented. Guarantees a tight stuffing box and steadies the rods and stems without causing friction. Keeps the rod smooth and lasts for years and years.

We'll pack ANY TYPE of steam engine or pump and guarantee satisfaction, or money back. Write for catalog and testimonials.

**Monarch Steam Blower Co.,**
**Troy, N. Y.**

# TAKES A STRIP OF PAPER 6 FEET LONG




# THE THOMPSON INDICATOR

with outside spring and continuous diagram, takes its record over a period long enough to eliminate errors, caused by constantly changing loads.

The roll of paper may easily be changed without disconnecting the indicator.

*Write For Full Particulars*

**THE SCHAEFFER & BUDENBERG MFG. COMPANY**

**MAIN OFFICE AND WORKS:**
963-5 KENT AVE., BROOKLYN, N. Y.

**WESTERN SALESROOM:**
15 W. LAKE STREET, CHICAGO

# A FEW ADVANTAGES

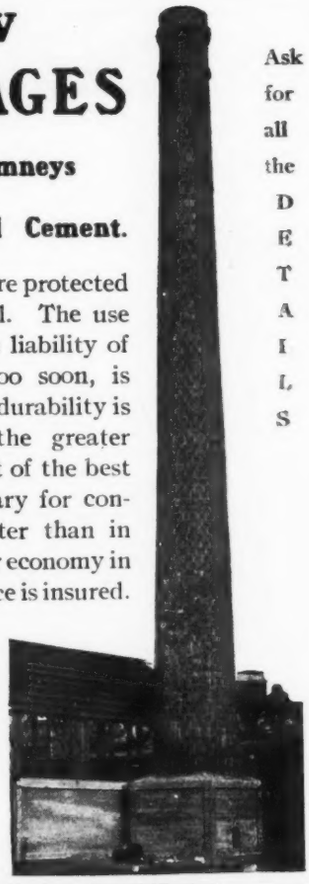
OF

**Wiederholdt Chimneys**

MADE OF

**Fire Clay Tile and Cement.**

All concrete surfaces are protected by a heavy fireclay wall. The use of wood forms, and the liability of their being removed too soon, is eliminated. Chimney's durability is greatly increased by the greater strength of tile over that of the best concrete. Time necessary for construction is much shorter than in any other type. Greater economy in first cost and maintenance is insured.

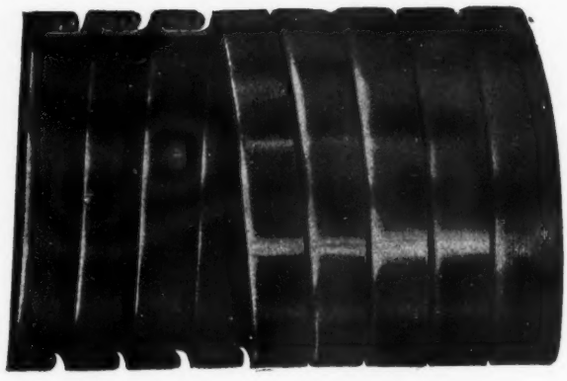


Ask for all the DETAILS

**WIEDERHOLDT CONSTRUCTION COMPANY,**

American Trust Bldg.

**Chicago, Ill.**



# PENNSYLVANIA

**Flexible Metallic Tubing**

is made of copper or galvanized steel tape rolled into spiral form in one continuous length. The interlocking edges enclose an asbestos thread packing.

Made in all sizes from ⅛" to 12", used for high pressures and all liquids, compressed air, steam, gases, oils, etc. *Write.*

# PENNSYLVANIA

**Flexible Metallic Tubing Co.**

S. H. COLLOM **1305 Arch St., Philadelphia, Pa.** H. A. ANSELL

NEW YORK, 86 Warren St. BOSTON, 71 High St. CHICAGO, 255 LaSalle St.
DETROIT, 631 Stevens Bldg.

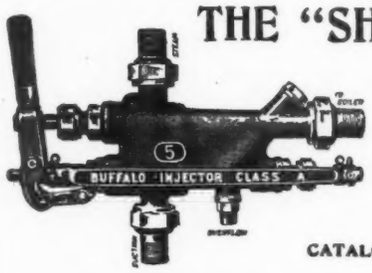
## U. S. Automatic Injectors have an International Reputation for Superiority.

They have just as firm a foothold abroad as at home. Only genuine merit has placed the "U. S. Automatic" in this position. The more particular you are about securing reliable boiler feeding—the better it pleases us—for we have the **only reliable boiler feeder.**

Send for our Engineers' "Red Book"—it slips right into the vest pocket, small in size, but large in information.

**American Injector Company,**
**Detroit, Michigan.**

## THE "SHERWOOD" INJECTOR




Injectors, Ejectors, Gauge Cocks, Boiler Tube Cleaners, Flue Scrapers and Blowers, Oil Cups and Pumps, Lubricators, Automatic Oil Pumps, Grease Cups, Special Brass Work.

CATALOGUE AND PRICES SENT ON APPLICATION.

SHERWOOD MANUFACTURING CO.,
BUFFALO, N. Y.
**Manufacturers of Engine and Boiler Supplies.**

## THE "HART" OIL PUMP

## STARRETT TOOLS ARE STANDARD

**Lasting Satisfaction**

There is a LASTING SATISFACTION about using the best tools made—satisfaction to you—satisfaction to those who use the product of your labors.

Ask for Catalog No. 18AG—the catalog of "lasting satisfaction" tools.

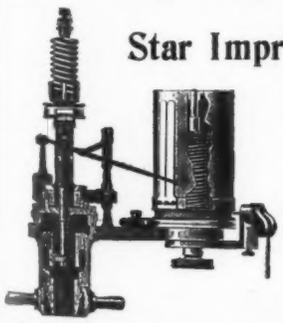
**THE L. S. STARRETT COMPANY,**
**ATHOL, MASS., U. S. A.**

## A PERFECT INDICATOR

IS THE

**Star Improved Outside Spring**

Class B Style.



Suitable for.....
High Pressures,
High Speeds,
Superheated Steam,
and all uses where absolute accuracy is required.

A QUALITY INSTRUMENT.

*Send for Circular.*

Manufactured Exclusively By

Star Brass Mfg. Co., 108-114 E. Dedham Street, Boston, Mass.

## A Powerful Little Device for Elevating, Conveying and Transporting Liquids—

# The Garfield Ejector

Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

Note the straight pipe connections making it desirable for elevating water from deep driven or drilled wells.

**Positive in Its Work and Nothing to Get Out of Order**

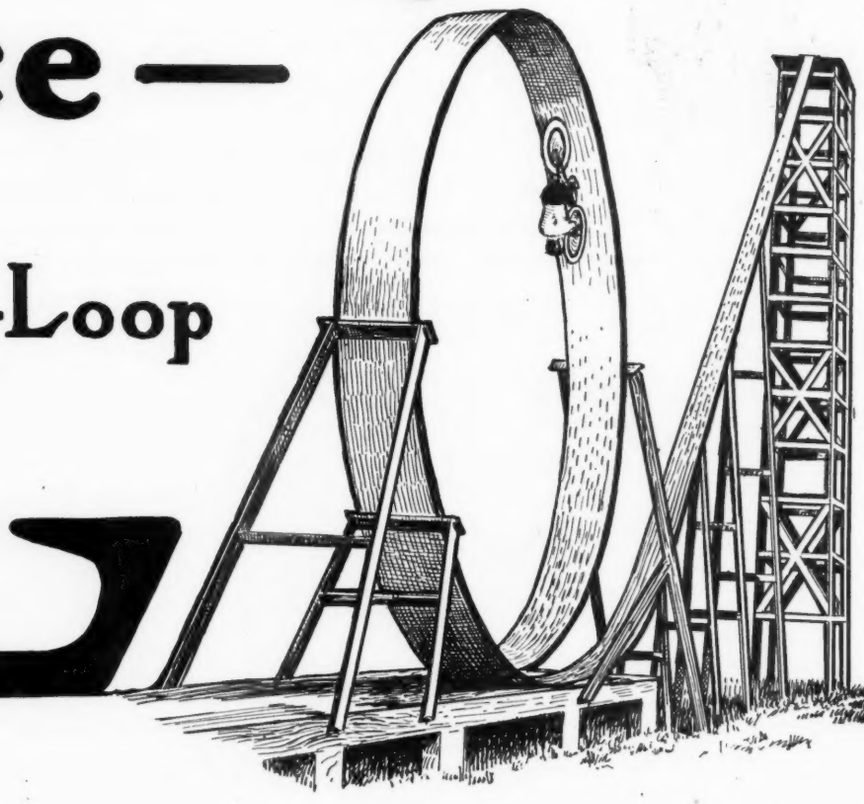
You cannot afford to be without it. Write for complete description. Large Catalog sent free.

**The OHIO INJECTOR CO.,**
The World's Greatest Injector Manufacturers,
**WADSWORTH 110 Main St. OHIO, U. S. A.**

# Centrifugal Force—

## the Loop-the-Loop idea

**which is applied in**



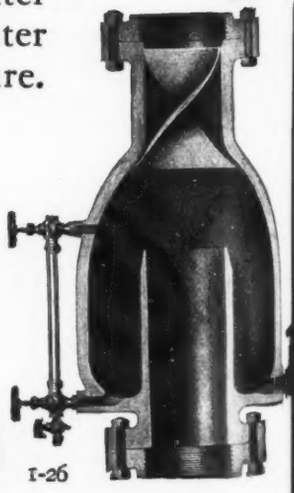
## The "Swartwout"

### Cast Iron Exhaust Heads, Steam and Oil Separators

is absolutely irresistable. The heavy particles of water and oil simply have to part company with the lighter steam, which flows directly on without loss of pressure.

THERE IS NOTHING SIMPLER

**Send for our new Catalogue No. 116 P**
and study the action of the Helico-Centrifugal Principle.



## The OHIO BLOWER CO.

**CLEVELAND, OHIO**

**Also Manufacturers of**
**"Swartwout" Gravity Closing Ventilators**

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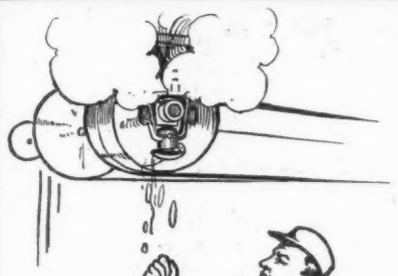
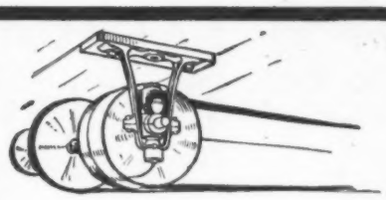
THERE IS ONLY ONE

# ALBANY GREASE





THE SUBSTITUTE

Nothing Worse I Can Imagine

The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.

Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

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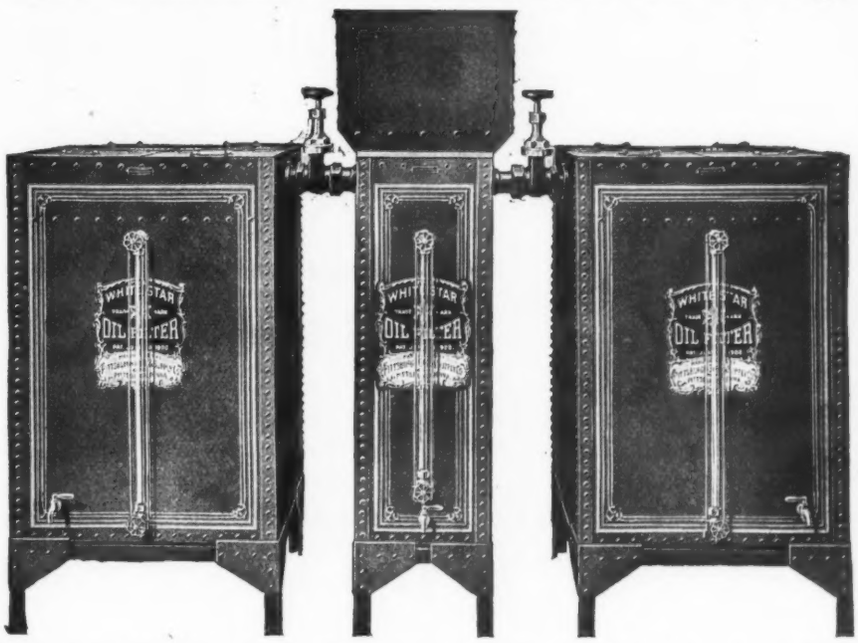
THE ONLY GENUINE.

# WHITE STAR OIL FILTER

**MULTIPLEX TYPE—Used exclusively in oiling systems of the largest capacities.**

**Will take care of any amount of oil.**

**Nothing too large.**



**Successfully employed by the Lackawanna Steel Co., Buffalo, N. Y. on 48,000 h.p. gas and Steam engines and others.**

**Our catalog "D" treats fully the subject of Engine Lubrication—Send for it.**

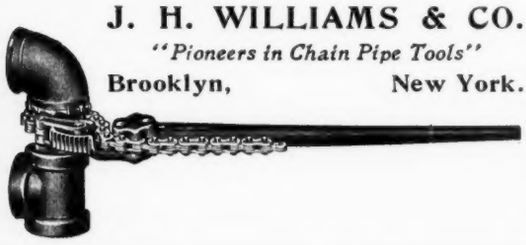
**Pittsburgh Gage & Supply Company, Pittsburgh, Pa.**

# Discarded Features

See the chain? Sense will tell you that its weight alone will release it from its locking pockets, and in working overhead this is matter of extreme danger and importance when in elevated positions. We will not offer make-shifts and death-traps. Years ago we discarded the one side chain fastening feature. Now it is being advertised as a new thing, permitting shifts from right to left without removing from pipe. It will permit shifts, but not with safety in all positions. The chain-wrench business has been our study for a lifetime.

In the **"Agrippa"** we have a combination of safety, strength and universal utility that cannot be beaten.

Guaranteed and on trial from dealer.



**J. H. WILLIAMS & CO.**

*"Pioneers in Chain Pipe Tools"*

**Brooklyn, New York.**

## 3 Pints of Oil in 28 Days

**Latest Improved**

# ROCHESTER

**Automatic Lubricators**

result in a great saving of oil. This is proved by the fact that a three-pint "Rochester" on a certain marine engine was only filled once on an almost continuous run of 28 days.

Our lubricators can save oil for you. Do you think it is worth while to investigate?

*WRITE FOR INFORMATION.*

**Greene, Tweed & Co.**

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Detroit Improved Standard Lubricator

## Some One

of our 337 different styles and sizes of sight-feed lubricators will fill any requirement you may have.

When ordering, insist on getting the genuine Detroit.

Write for a catalog of the most complete line of oiling devices for all purposes.

**DETROIT LUBRICATOR COMPANY.**

**Detroit, U. S. A.**

## Reduce Your Oil Bill More Than One-Half

## The Acme Oil Filter

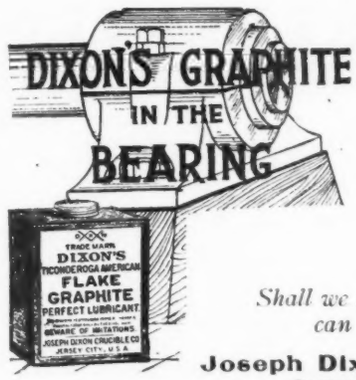
is no more expensive in first cost than other filters and is cheaper by far in the end. It uses only pure animal bone black as a filtering material and the saving effected by one Acme would pay for ten or more.

*WRITE*

**WALTER L. FLOWER**

**STEAM SPECIALTY COMPANY**

**311 So. 8th St., ST. LOUIS, MO.**




fills up the inequalities of the surfaces, imparting a smoothness which it would be absolutely impossible to secure with oil or grease alone.

*Shall we send you sample can No. 94-C?*

**Joseph Dixon Crucible Co.**
**Jersey City, N. J.**

# HARRIS

TRADE MARK REGISTERED

## OILS

**HARRIS VALVE OIL** — **HARRIS ENGINE OIL**

These two brands will give more lubrication at less cost than any others.

Let us lubricate your plant for two or three months under guarantee of better results at decreased cost.

We invite inquiry and are always glad to send barrels on approval.

**A. W. Harris Oil Co.,**
**323 S. Water St., Providence, R. I.**

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## For The Engine

ANTI-CORROSIVE CYLINDER OIL
MANUFACTURED ONLY BY E. H. KELLOGG & CO.

A very little poison taken internally will save you a lot in grocers bills but the doctor's bills or funeral expenses more than make up the difference.

Just so you can economize on cylinder oil, but engine repairs will offset the saving.

We will send you a barrel of Anti-corrosive on 90 days' trial—if it satisfies you, pay our price, if not, pay whatever you think right and we'll send a receipt in full.

*WRITE TODAY*

**E. H. KELLOGG & CO.,**
**243 South Street, NEW YORK, N. Y.**
*8 B Rumford Court, Liverpool, Eng.*

TRADE MARK. NON-FLUID OILS REGISTERED IN UNITED STATES PATENT OFFICE

## NON-FLUID OILS BETTER THAN GREASE

No lubricant should require what it is suppose to prevent, but GREASE won't lubricate unless assisted by frictional heat from the bearings. Then it melts like ice; hence it runs out instead of into the bearings.

NON-FLUID OILS don't require heat to act and are never affected by temperature. Being MINERAL oils condensed they lubricate the same in January as in August. Their quality never changes. No gumming, getting rancid, or useless waste and muss.

Send for a free sample. You will find it the best lubricant you ever used.

ORIGINATORS AND SOLE MANUFACTURERS

**NEW YORK AND NEW JERSEY LUBRICANT CO.**
**Dept. A., 14-16 Church St., New York**

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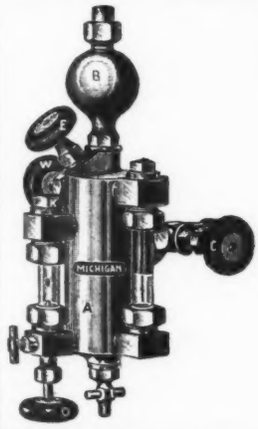
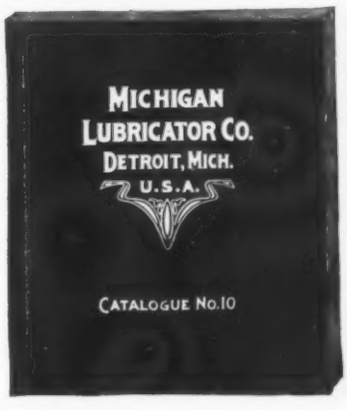
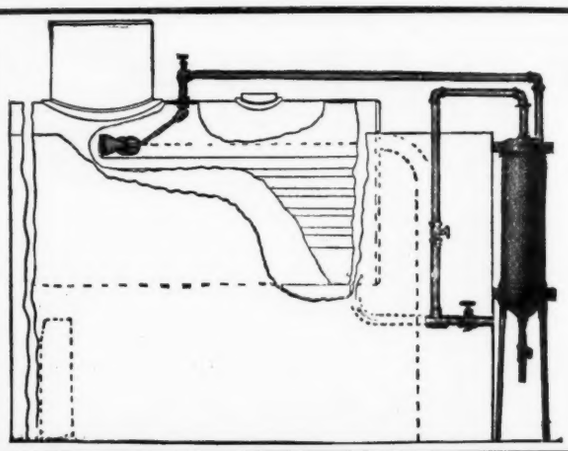



# Michigan Lubricators

**ENGINEERS**
**WE WANT YOU TO HAVE A COPY OF OUR No. 10 CATALOG—108 PAGES**
**—SENT FREE—**

**MICHIGAN LUBRICATOR COMPANY**
**DETROIT, MICHIGAN**





# SCALE PREVENTED

**At No Expense Save First Cost.**

And the first cost of a Buckeye Automatic Boiler Skimmer is a mere trifle compared to its saving in fuel, repairs, time and trouble.

For 30 days we'll send one free—will you try it?

**BUCKEYE BOILER SKIMMER COMPANY,**
**SOUTH END, TOLEDO, OHIO.**

# STERLING

Force Feed Lubricators can be adjusted to deliver from a fraction of a drop to an almost continous stream of oil, according to the needs of the machine. They furnish a perfect oiling system of greatest economy.

*CATALOG ?*

**Sterling Lubricator Co.**
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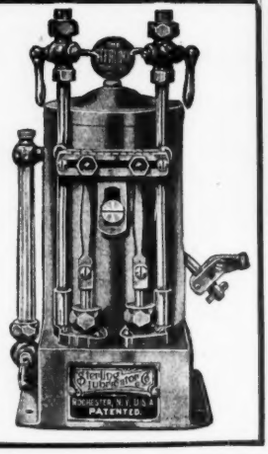

PURE WATER FOR THE BOILERS BY THE

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Water Softening and Purifying Systems.

RESULTS GUARANTEED SEND FOR OUR CATALOG.

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Nugent's Valuable Treatise on
**HOW TO OIL AN ENGINE**
and large catalog No. 7 A of new and
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# We Challenge You

to find a bearing in your entire plant which Mica Flake Lubricant will not keep cool—or a hot bearing which Mica Flake Lubricant will not cool while running! Our challenge is contained in a small envelope sample, freely offered for demonstration purposes, of

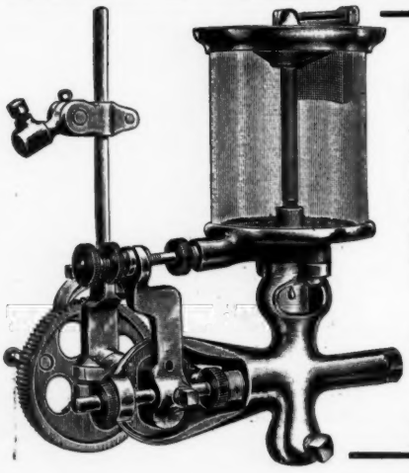
## Mica Flake Lubricant

Do you accept our challenge? Send for the test sample! Mica Flake Lubricant is radically different, in principle and performance, from Graphite or any other lubricating material.

Keeps the metal bearing surfaces actually apart—reduces friction—cools hot journals—lengthens the life of your oil—saves costly delays and break-downs—increases operative efficiency!

Mica Flake Lubricant is pure Mica—pure white—will not discolor or damage fabrics. Write for literature, prices, and the test sample!

***THE UNITED STATES MICA COMPANY,***
***238-240 LaSalle Street, Chicago, U. S. A.***



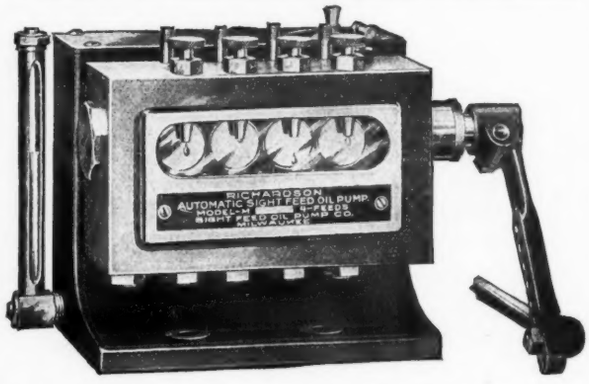
# 30 Days' Free Trial

Take the Manzel Force and Sight Feed Oil Pump and compare it with any other system of lubrication. It oils according to the engine's need. No more, no less.

*WRITE !*

**MANZEL BROS. COMPANY**
**326 Babcock St.**
**Buffalo, New York**

# NEW MODEL "M"




## Richardson Sight Feed Oil Pump

To those interested in the details of construction, a story about the kind of material used and the valuable improvements incorporated, will be found in bulletin No. 109. May we send you one?

**Mfd. by**

## Sight Feed Oil Pump Co.,

**Milwaukee, Wis., U. S. A.**

Cling-Surface is a preservative treatment for belts and ropes, a food, which penetrates into them, making and keeping them pliable, waterproof and preserved—not sticky, prevents all drying out or cracking.

And at the same time stops all slipping so all belts or ropes can be run easy or slack and carry fullest loads.

You can't do this without Cling-Surface and we guarantee results. Write us.

**Cling-Surface Company**

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## DONT LET SCALE EAT YOUR PROFITS

Scale keeps heat OUT of a boiler more effectively than coverings keep it IN. Besides prolific repair bills, and possible explosions, scale means nasty, sloppy work on cleaning days.

**Scale Prevention with**

## BIRD-ARCHER BOILER COMPOUNDS

at much lower cost and no delays is far more profitable than scale removal at $50.00 or so per boiler and several weeks' shut down per year, to say nothing of wasted coal while scale is collecting.

If Bird-Archer Compound doesn't keep your boilers in better shape than any other scale remedy, it won't cost you a cent.

**Try it for six months on this "NO CURE, NO PAY" basis.**

WRITE FOR PRICES.

**BIRD-ARCHER COMPANY,**
**90 WEST ST., NEW YORK.**

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## THIS SHULTZ SABLE BELT

**is made by a special tanning process that preserves the original strength and pliability of the rawhide while giving it a smooth kid-like surface. That is the reason it clings to the pulleys without slipping.**

A belt that does not slip does not need a heavy tension and does not require dressing to make it stick to the pulleys.

SABLE BELTING will transmit from 25% to 33% more power and give longer service than ordinary oak-tanned belting.

Ask for our Belt Book "No. 4."

**Get a SHULTZ SABLE BELT for 60 days' free trial.**

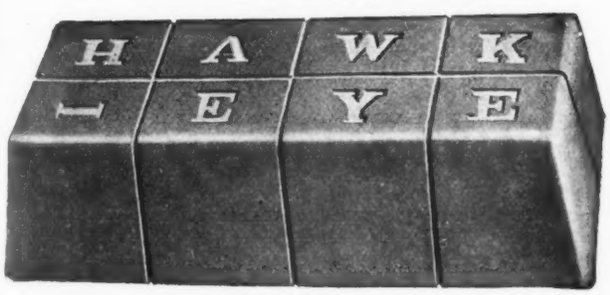
**SHULTZ BELTING CO.**
**ST. LOUIS, MO.**

NEW YORK, 111 Chambers St. BOSTON, 114 High St. PHILADELPHIA, 116 N. 3rd St.

No. 29

## The Hawk-Eye Is The Only Boiler Compound Company

All other firms deal in other articles.



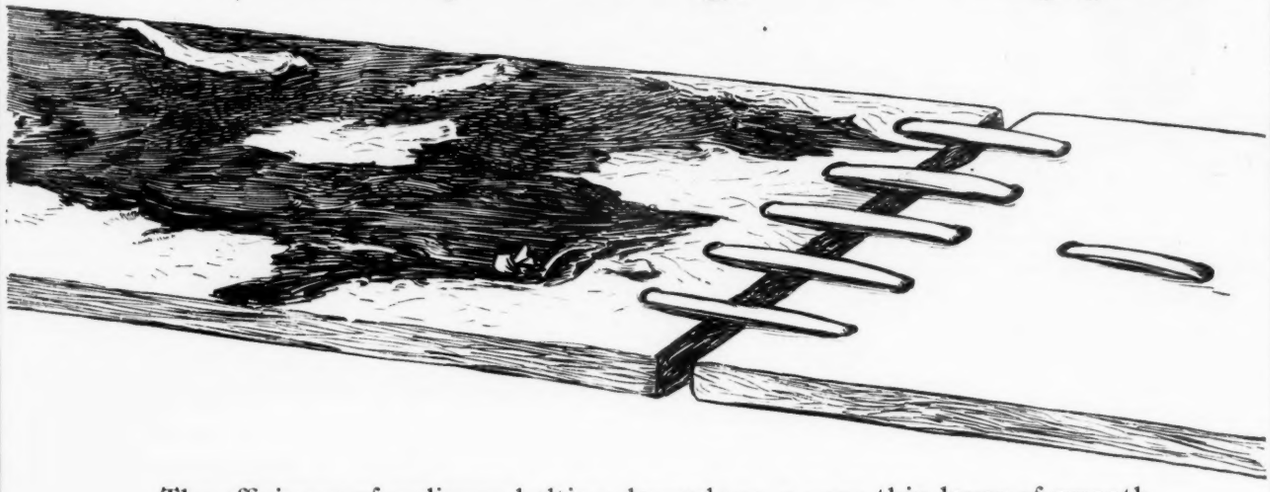

Eight one-pound squares in every block.
There is no acid in our compounds.

If a physician attempted to plead a law case in court he would be called a Jack of all trades and those who are engaged in all kinds of business and at the same time attempt to manufacture boiler compounds are Jacks of all trades and Masters of none.

After you have grown tired of spending money with that class, send us an order and you will not regret it.

**Hawk-Eye Compound Company**
**303-304-305 Merrick Block, CHICAGO, ILL.**
**'PHONE WENTWORTH 135**

# When the Surface is Pulled Off Ordinary Belting, it is Crippled.



The efficiency of ordinary belting depends on a very thin layer of smooth, porous, "hair-side" leather, which comes next to the pulley—and when that's gone, 50% of the quality of the belting has disappeared.

# "Edge-on" LEATHER BELTING

never has that surface to lose. It never needs it, as the ends of the leather fibre make a much better surface to hold to the pulley than any "hair-side" could—and it can never be destroyed or stripped off.

"Edge-On" Laminated Belting has solved the problem of efficient, economical power transmission. It is a cementless, lapless, endless, practically stretchless belt that excels all others in durability and reliability.

*LET US SEND YOU FULL DETAILS.*

PATENT LAMINATED BELT * CEMENTLESS LAPLESS ENDLESS * C CAN'T FAIL F A ANYWHERE

U. S. Patent Dec. 3, 1907.

## Laminated Belting Company,

**Operating under patents granted in United States, England, Canada, Mexico, Spain, France, Belgium, Italy, and other patents in United States and abroad pending.**

**51 Beekman Street, New York.**

**CHICAGO BRANCH: 44-46 Franklin Street.**

Like the man with money to burn, is the factory that uses belts that slip.

# Rhoads Leather Belting

is so made as to transmit your power economically, especially when used with

## Rhoads Leather Belt Preserver

Both have proved this by many years of service.

**J. E. RHOADS & SONS,**

**Philadelphia, 12 N. Third Street**
**New York, 40 Fulton Street**
**Boston, 105-111 Summer Street**
**Hamblet & Hayes Co., Eastern Agents**

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## The Only All-Wrought Steel Pulley

Safe at high speeds, true running, strong, rigid and practically indestructible

**THE AMERICAN PULLEY**

weighs one-third less than a cast iron pulley of equal size, fits shafts of various sizes and over a million of them are proving satisfactory in service.

**Sold By Supply Houses Everywhere.**

*Patented in the U. S. and foreign countries.*

Our Booklet?

**THE AMERICAN PULLEY CO.**

**29th and Bristol Sts., Philadelphia, Pa.**

## The Belt Wont Slip On A Hercules Leather Covered Pulley.

till the power transmitted is many times that required to cause slipping on an uncovered pulley. Let us tell you about the excellent results our customers are getting from the use of our leather pulley cover. The reports please us. The results will please you. Our Hercules cement will hold it on any kind of pulley.

**Hercules Pulley Cover Co.,**

**Detroit, Mich.**

GENUINE

## GANDY

**Steam and Waterproof**

Unaffected by acid fumes, and almost wearproof; it's no wonder

**Gandy Red Stitched Cotton Duck Belts**

are displacing all others. The fact that they run straight and true and can be run slack without slipping, coupled with their low price, one-third that of leather, completes the argument and leaves no doubt of their superiority. Send for our free booklet, "Experiences with Gandy," and read the views of men who use them.

*(Another money saver—Gandy Belt Dressing.)*

THE GANDY BELTING Co.

BALTIMORE MD.

## THREE STEEL ROLLERS

lodged in each forked lever, act with immense force on the friction discs of

**THE AKRON CLUTCH**

This Roller Toggle picks up the load with greater ease and releases it more promptly than any other mechanism ever devised.

***Write.***

**The Williams Foundry & Machine Co.**

**Akron, Ohio**

**Successors to the Akron Clutch Co.**

## OXoilOX

VIENNOT-PHILA

### A GOOD START

is half the battle, and the very best start for *any new belt* is a thorough treatment with OXoilOX—*The Perfect Belt Dressing.* It restores to leather the strength and vitality lost in tanning. Makes belts tough, yet soft and pliable, so that they adhere closely to the pulleys, and slipping is made almost impossible.

*OXoilOX* is not a "*dope*," and it doesn't make belts sticky; just keeps them clean and healthy so that they can live out their full life and do a good day's work each day. You can have

**A FREE SAMPLE**

**F. S. WALTON CO., Philadelphia, Pa.**

**Gentlemen: Kindly send us, free of charge, a sample can of OXoilOX the Perfect Belt Dressing.**

Name.....

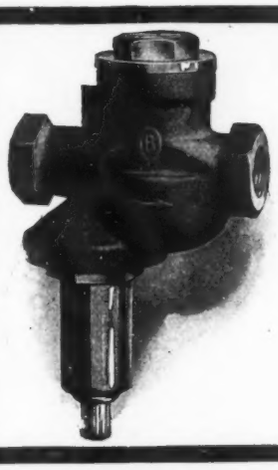
Address.....

Name of Firm.....

Number of Belts..... Average Size.....

**F. S. WALTON CO., Philadelphia, Pa.**

**Pressers and Refiners of all grades of Neatsfoot oil**

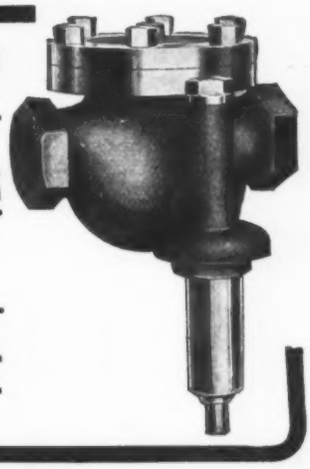


# Have You Regulator Troubles?

If so, you can end them permanently by installing the

## COLLIN STEAM PRESSURE REGULATOR

which insures continuous satisfactory service.
Made in sizes from ¾" to 8" inclusive.
*Illustrated Catalogue "B-E" gives full description and list.*



**THE OHIO BRASS CO., Mansfield, O.**
**NEW YORK, 32 Cortlandt St. CHICAGO, 277 Dearborn St.**
**SAN FRANCISCO, 138 Front St.**

**The Philips Pressed Steel Pulley**

# Up-To-Date

builders, whether building houses, ships, pulleys or fortunes, use

## The Truss Principle

because it affords unparalleled strength, larger construction with less weight, greater durability, safety convenience and speed.

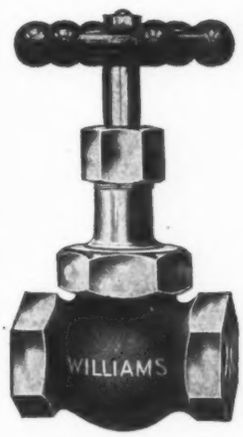
Study its construction closely and you will see

## The Philips Superiority

*BOOKLET ?*

**PHILIPS PRESSED STEEL PULLEY WORKS,**
**Fourth & Glenwood Ave., Philadelphia, Pa.**

# Let The Williams Valve Prove Its Worth To You.




THE BEST WAY to determine the value of a Williams valve is to *try it*. Try it in places where other valves won't stay tight—in other words give it the most severe test you can think of.

You will find the Williams valve particularly strong at any pressure up to 200 pounds and on account of its high-lifting disc and large seat opening, friction is reduced to minimum.

**Can Be Repacked Under Pressure.**

One feature of the Williams valve, that appeals to every engineer, is the fact that it *can be repacked* under full pressure of steam or liquids, without any danger of the operator being burnt or scalded. This is easily and quickly accomplished by simply having the valve wide open.

There are many other good points in the Williams valve which you will like—if you only try one.

*Write—WILLIAMS on your next order.*

**THE D. T. WILLIAMS VALVE CO.**
**904-910 Broadway, - CINCINNATI, OHIO**
1

# Robins Laminated Leather Belting

## *Eliminates The Glue Pot*

SOLVES THE BELT PROBLEM.

*The Scientific Principle:*
**Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.**

*The Positive Result:*
**A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.**

*Write for Circular No. 2 giving detailed description.*

**ROBINS NEW CONVEYOR COMPANY**

*NEW YORK,* **38 Wall Street.** *FACTORY,* **168 Duane Street, N. Y.** *CHICAGO,* **Old Colony Building.**

WHICH is the better engineer—the one who can say "I know how to do that" or one who says "Send for Mr. Smith —he's an expert."

# Engine-Room Chemistry

*is a new book by Prof. A. H. Gill that will make any engineer who can read English an expert along certain lines of power plant practice that are vital to his interests.*

Without the necessity of any previous chemical knowledge, from the very beginning of the simple chemistry of the engine-room, this book will take you to that point where you can make your own analysis of the feed water and neutralize its scale-forming propensities; where you can analyze flue gases and regulate combustion to a certainty; where you can analyze lubricants and know what ingredients they require to best suit your purpose; where you can know the quality of fuel you're paying good money for.

Engine-Room Chemistry takes you 'way past the point where ordinary engineers stop. Will you take the trip?

**Guarantee**—*Send us the price of the book, $1.00. We'll ship it, postpaid. If you don't like it and return it in good condition within 5 days of receipt, we'll refund your money at once.*

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*Inclosed find* $1.00. *Send Engine-Room Chemistry subject to your guarantee.*

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**Hill Publishing Company,**
**505 Pearl St., New York**

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*Power* *American Machinist*

*The Engineering and Mining Journal*

# Nelson Valves

## Advantages Gained by the Use of Bolts, Instead of Studs

United States Standard Hexagon Head Bolts, with United States Standard Hexagon Nuts, are used at every joint possible, in Nelson Valves. **United States Standard**—because larger, stronger, and more efficient than the smaller standards; **Hexagon**—because they have the best bearing value, offer more points of contact for grip of wrench than any other, allow greatest swing of wrench in turning, and present a finished appearance; **Bolts, instead of studs**—because studs become rusted and break off, are difficult to tap out when broken, and replacement is not easy; while, with bolts, liability of breakage is minimized, and they can very easily be taken out or replaced.

The use of the best bolts is just one of the many details in manufacture that marks the superiority of Nelson Valves.

They are guaranteed—absolutely and expressly.

**The Nelson Valve Company,**
**Philadelphia.**

New York, Hudson Terminal Bldg.
Chicago, . . 40 Dearborn Street
Pittsburgh, . 525 Third Avenue
Minneapolis, . . 622 Andrus Bldg.
San Francisco, . Atlas Building
Butte, Mont., . 56 E. Broadway

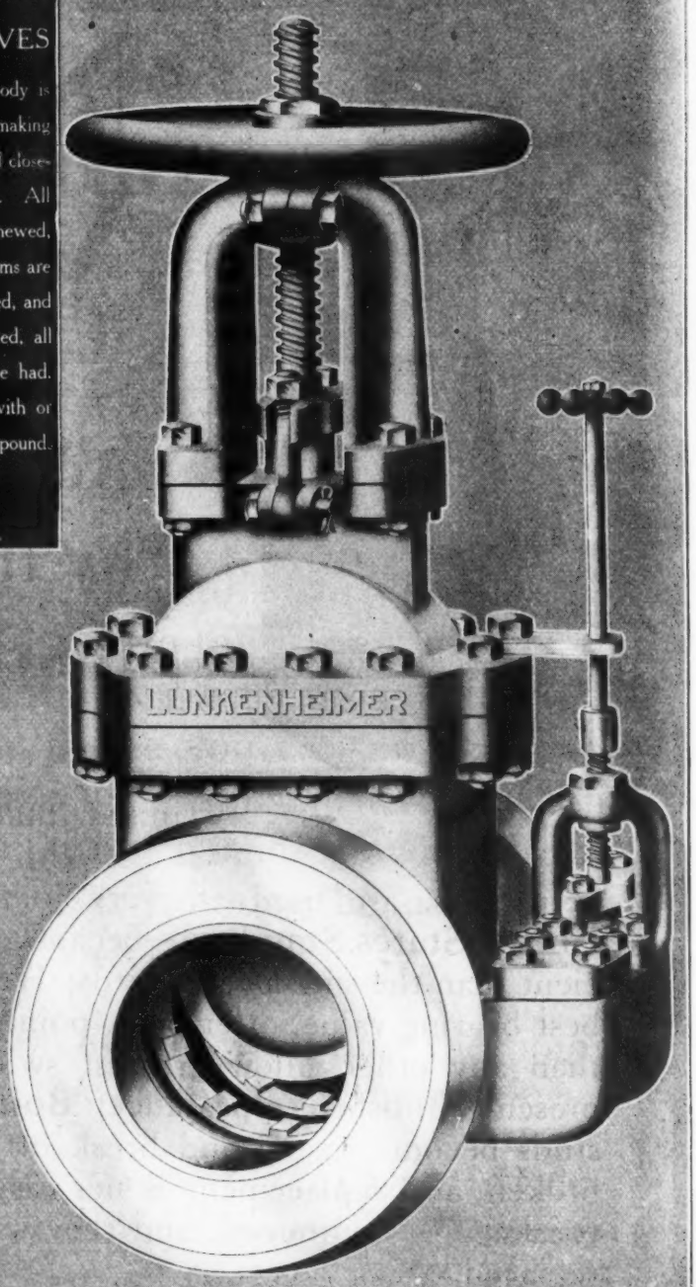
# THE VICTORS

is a trade name that users claim is applicable only to LUNKENHEIMER make of GATE VALVES. Upon investigation it will be found that

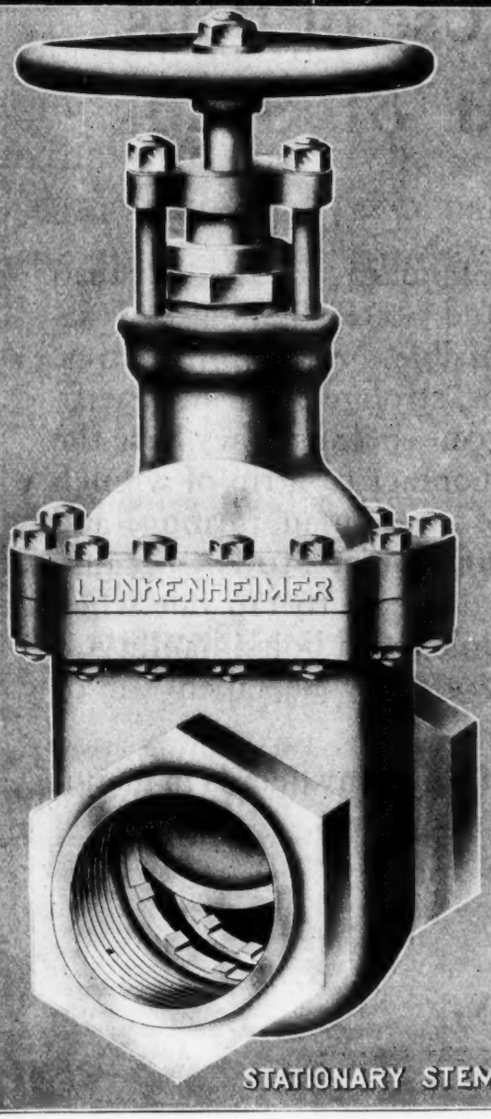
## LUNKENHEIMER VICTOR GATE VALVES

are of exceptionally good design. The passage through the valve body is free and unobstructed,—all parts are large and well proportioned, making the valve as a whole very strong and rigid. The iron used is hard and close-grained, and has a tensile strength of 25,000 pounds per square inch. All parts subjected to wear, including the seats and discs, can easily be renewed, and are made of the highest grade of bronze composition. The stems are also made of bronze. The valves are absolutely tight, are double-seated, and will take pressure from either end. Either iron body brass mounted, all brass, or "Puddled" Semi-steel valves for superheated steam can be had. They are made with outside screw and yoke or stationary stem, with or without by-pass, in three weights, suitable for 125, 175 and 250 pound working pressure.

A trial will convince you of their superiority. Write for catalogue.




OUTSIDE SCREW AND YOKE WITH BY-PASS




STATIONARY STEM

## The Lunkenheimer Company

Largest Manufacturers
of High Grade Engineering Specialties in the World

General Offices and Works, Cincinnati, Ohio, U.S.A.

New York, 66-68 Fulton St.
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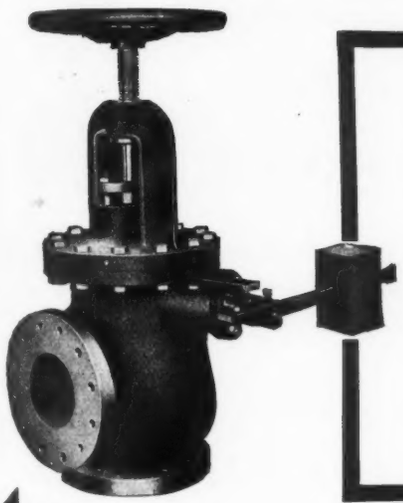
498

# WOULD SUCH ACCIDENTS DEAL OUT DEATH AND DESTRUCTION IN YOUR PLANT?



(415.)—A tube burst, November 22, in a water-tube boiler in a cotton mill at Kingston, Ont. Engineer was terribly and perhaps fatally scalded.

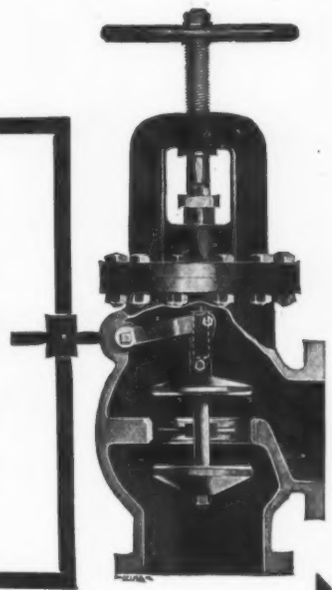
(246.)—A blow-off pipe ruptured, July 16, 1907, in mill at Anderson, S. C. Fireman was scalded.

(133.)—A tube ruptured, April 4, in a water-tube boiler at a boiler plant, Chicago, Ill. A coal passer was scalded.

(13.)—A boiler flue burst, January 15, 1907, in round house at Moorhead, Minn. A machinist was badly scalded and he died a few hours later.

(32.)—A number of cast-iron headers fractured, January 27, 1907, in a water tube boiler at a sugar plant in Neb. Attendant was severely scalded.

—FROM INSURANCE LISTS.



About 400 boiler failures are reported every year, to say nothing about those which never come to light. Careful analysis shows that by far the greatest percentage is due to ruptured or collapsed tubes, failure of blow-off valves and man-hole covers, cracked headers, bursting steam mains or other accidents which could be robbed of their greatest terrors by stopping the flow of steam. Boiler damage may be insignificant, but the water and steam let loose may do more harm than indicated in the clippings.

We can cite hundreds of instances where the firemen or boiler room attendants thus lost their lives, were maimed for life, or were badly scalded.

# LAGONDA AUTOMATIC CUT-OFF VALVE

placed on the steam line of every boiler will do more to prevent loss of life and damage from minor boiler accidents than any other protection that could be put in the plant. When a tube bursts it shuts off the injured boiler before all the boilers in the battery can pour their contents through the break. If a main opens, the valve on each boiler closes instantly.

The LAGONDA AUTOMATIC CUT-OFF VALVE may be used as an ordinary stop valve, gives more protection than a "NON-RETURN" valve and can be installed without changing the piping lay-out.

It costs so little more than the plain valve that every plant can afford this protection. Try it, and if you are not satisfied with the results, send it back.

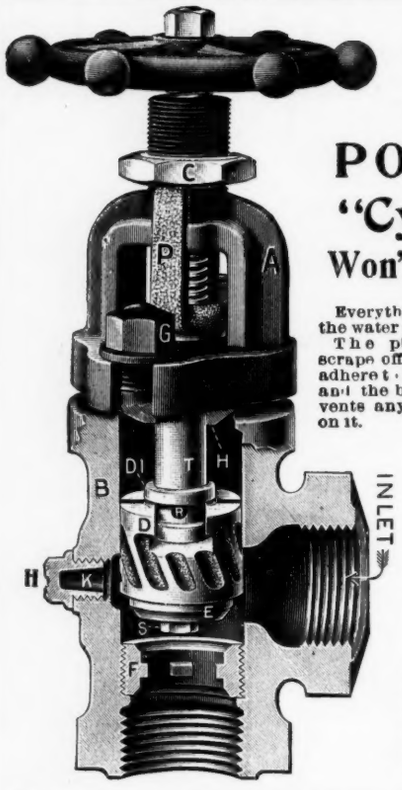
*Write for our "Cut-Off Valve" Bulletin.*

## LAGONDA MFG. CO., Springfield, O.

**Makers of Weinland Boiler Tube Cleaners and Lagonda Reseating Machines and Tube Cutters.**

New York Philadelphia Pittsburg Chicago San Francisco Birmingham Toledo London

[64]




No matter how muddy the water may be, or how much scale passes out with the water, the

**POWELL "Cyclone" Won't Choke Up**

Everything must go out with the water and steam. The plunger is grooved to scrape off anything that might adhere to the sides of the body, and the bevel on the seat prevents anything from lodging on it.

**The POWELL "Cyclone" Blow-Off Valve**

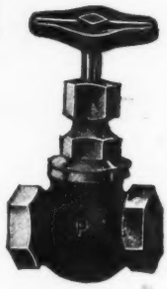
has more good points than any other blow-off valve on the market today. We have a circular we would like to send to you—a postal brings it.

**THE WM. POWELL CO., Cincinnati, Ohio.**

NEW YORK, 254 Canal St. PHILADELPHIA, 518 Arch St.
BOSTON, 239-245 Causeway St.

**IF YOU ARE INTERESTED IN POWER PLANT EQUIPMENT YOU WILL BE INTERESTED IN**

**PITTSBURGH BRASS GLOBE VALVES**



**THEY are made as nearly perfect as the best skilled mechanics and newest approved machinery will allow.**

THEY ARE MADE OF HIGHEST GRADE STEAM METAL and ARE UNCONDITIONALLY GUARANTEED.

**PITTSBURGH VALVE & FITTINGS CO.**

GENERAL OFFICES and WORKS, BARBERTON, O.

We manufacture all kinds of Valves and Fittings.

# Nickel Bronze Seats and Discs

will not warp or twist at high temperatures and are impervious to the cutting effect of superheated steam.

**Whale Brand Valves** are consequently the ideal valves for superheated steam at high pressures.

CATALOG ?

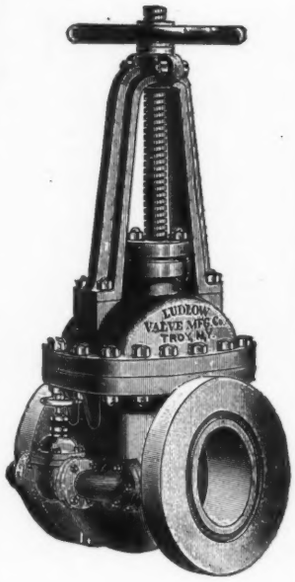
**The New Bedford Boiler & Machine Company**

Established 1872,

**New Bedford, Massachusetts**

# We Manufacture The Best Valves

because our material, workmanship and designs are all superior to best in use by other valve manufacturers.



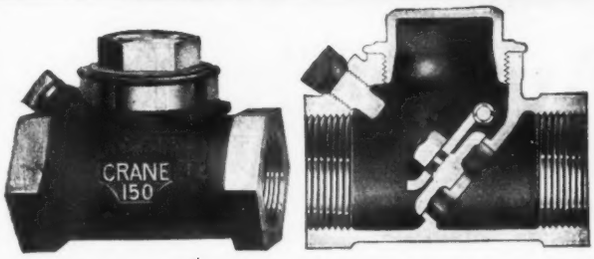

**LUDLOW VALVES**

are subjected in our shop to tests much more severe than any they will ever meet in actual service.

Write for our Catalog.

**The Ludlow Valve Manufacturing Co.,**

Adams Street, Troy, N. Y., U. S. A.




## STRAIGHT-WAY CHECK VALVES

**WITH REGRINDING SEATS**

THESE valves are designed for the most exacting service, on pressures up to 150 pounds. All parts are made of a superior bronze mixture. The distribution of metal gives ample strength without unnecessary weight.

Valves have full area and operate horizontally or vertically.

The seat is placed at such an angle that the force of impact of disc is reduced to the minimum, decreasing wear on disc as well as noise of hammering.

Side hub and disc-stop are made up with tapered joints to overcome the tendency to leak at these places.

Regrinding is a very simple operation and requires but a few minutes.

**Made in sizes up to 3 inch, screwed or flanged.**

## CRANE CO.,
**CHICAGO.**

ESTABLISHED 1855.

## CEASE WORRYING

**PUT ON AN**

## ECLIPSE BLOW-OFF VALVE

**And all your troubles will be a thing of the past.**

Since Boilers were first made the Blow-Off Valve has been the source of constant worry and trouble.

This Valve is so made that it can be ground with full boiler pressure on.

The pressure is against the Disc holding it tight against the seat.

Have been on two years and more in places other valves did not last as many months.

Over *Two Hundred* in use in Illinois Steel Co. plant alone.

Send for Catalogue descriptive of this and our other specialties.

**Reducing Valves, Back Pressure Valves,**
**Pump Regulators, And other Devices.**

## THE JOHN DAVIS CO.,
**CHICAGO.**

REPRESENTATIVES—W. G. Ruggles Co., Boston; Central Supply Co., Indianapolis; J. A. Roe & Co., Detroit; Western Valve Co., St. Louis; Rob't B. Orr Engineering Co., Kansas City; A. M. Lochett Co., New Orleans.

## Is It Policy to Sacrifice The Harmony Of Your Entire Plant Through Careless Installation of Valves?

With wide-awake, progressive business men, **positively no!**

With such men no pipage equipment but the best will pass —**absolutely none but the best at the start!**

A plant equipped right at the start will remain right! A plant equipped right at the start will create safety and satisfaction to all concerned!

*Every valve and every piece of pipage equipment made by us is not only right at the start, but IT'S RIGHT FOR ALL TIME! Tuyeres, Tuyere Cocks, Regulators, Traps, Etc., Etc. Send for Catalogue.*

## PITTSBURGH VALVE, FOUNDRY AND CONSTRUCTION COMPANY

PITTSBURGH NEW YORK BOSTON
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## YORK MANUFACTURING CO.,
**YORK, PA.**

We manufacture all the machinery and parts needed to equip a complete Ice or Refrigerating Plant—Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings of all kinds.

We employ over 1250 men in the manufacture of Ice and Refrigerating machinery exclusively.

*CATALOG UPON REQUEST.*

Our fittings carried in stock at the following places:

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| United Iron Works, | 231 E. Second St., | Los Angeles, Cal. |
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DAVIS PRESSURE REGULATORS SAVE STEAM

PRESSURE REGULATOR

# Do It Automatically

If you are using live steam for heating, drying, cooking or some other purpose at a pressure lower than that carried on the boiler, let the Davis Pressure Regulator make the reduction for you automatically.

This valve can be adjusted to deliver steam at just the pressure needed and it will maintain that pressure without fluctuations no matter how much the initial boiler pressure may vary.

Reducing steam by throttling through a cracked globe or gate valve is about as satisfactory as using saw dust for fuel. You may be able to get along after a fashion, but why not do it right—automatically.

If you are running your engine non-condensing a Davis Automatic Back Pressure Valve will enable you to make use of the exhaust steam instead of letting it go to waste.

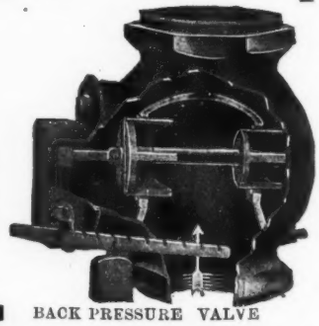
Contrast this valve with its semi balanced disc, small weight and noiseless operation without any possibility of injury to the seats, with the old style single seated valve which pounds like a trip hammer and keeps you poor buying seats for it. Is there any comparison—would you choose the single seat?

Send for a complete catalog of Davis Valve Specialties. It is of interest to both owner and operator.

**G. M. Davis Regulator Company,**

**142 Milwaukee Ave., CHICAGO.**

BRANCHES—NEW YORK—123 Liberty St. BOSTON—104 High St. ST. LOUIS, 735 S. 4th St.
SAN FRANCISCO—216 California St PHILADELPHIA—56 N. 2nd St.
PITTSBURGH—1206 Park Building.



BACK PRESSURE VALVE



TRADE-MARK CROSBY

## Perfect Safety for Your Boiler

can be gained if you have the right safety valve that acts reliably and automatically when the pressure limit is reached.

## Crosby Standard Pop Safety Valves

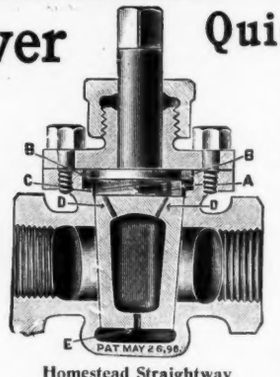
are the safest known devices, as they never stick on their seats and always open when the pressure at which they are set has been reached. They open wide, have free outlets and they relieve the boiler rapidly with the smallest loss of steam.

*Send for Full Descriptive Circular.*

**Crosby Steam Gage & Valve Co.,**

Boston New York Chicago London

# There's Never A Leak Where The Homestead Valve Is Working




Homestead Straightway Balance Plug Valve Locks by Quarter Turn.

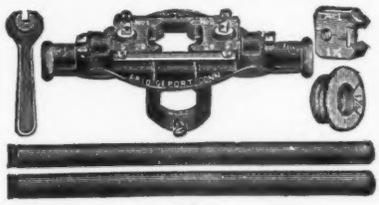
## Quick Acting, Simple, Durable

Homestead Valves are so made that they are almost wear-proof. Seat is protected from wear when pressure passes through; plug is balanced and held in place by pressure when open, and when closed is locked in the seat by our patent wedging cam, insuring freedom from friction in seat while plug is turning. Better Blow-off Valves cannot be made.

*Ask for booklet and learn all the features.*

**HOMESTEAD VALVE MFG. CO.**

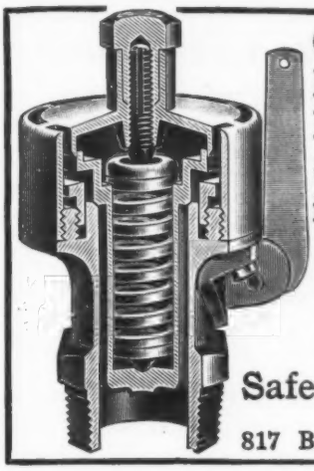
PITTSBURG, PA., U. S. A.



**Good Tools are the Workman's Best Friends**

All leading jobbers sell them.
Genuine ARMSTRONG TOOLS
made only by

THE ARMSTRONG MANUFACTURING COMPANY,
287 Knowlton Street, BRIDGEPORT, CONN.



**Over 600,000 of Kunkle's Patent Lock-up Pop Safety Valves now in actual use.**

For Portable, Stationary, Locomotive and Marine Boilers. They meet every requirement. We also make Mufflers for Locomotives. Write for details and prices.

**Fort Wayne Safety Valve Works,**
E. B. Kunkle & Co.,
817 Barr St., Fort Wayne, Ind.

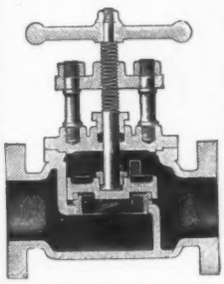
**Compressible Valve Discs**

in the Kennedy Valves conform readily to any irregularity of the seats and are renewable.

*Write.*

**The Kennedy Valve Mfg. Company,**
Elmira, N. Y.

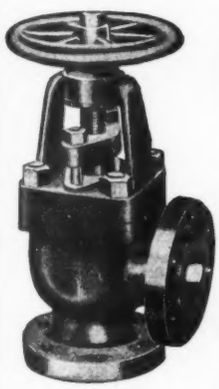
**"BELLVILLE VALVES"**



have the seat on the outside of an inverted cone where the direct current of steam does not come in contact with it, preventing all chance of wire drawing. Other features in catalog.

**Heavy, Compact, Durable,**
no marring by pipe tongs.

**Eastwood Wire Manufacturing Co.,**
BELLEVILLE, NEW JERSEY.



Manufacturers of the

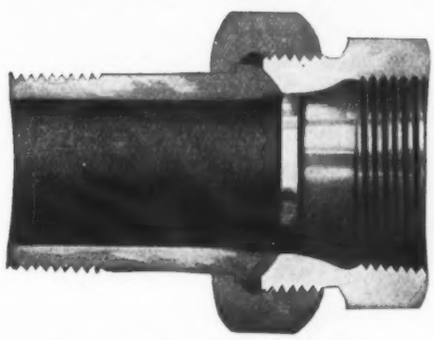
**EDWARD VALVE**

For High Pressures,
Superheated Steam and Water.

**THE LAMMERT & MANN**
Oil Dash Pots for Corliss Engines,
Gas and Gasoline Engines.

**LAMMERT & MANN,**
*ENGINEERS and MACHINISTS,*
157 S. Jefferson St. CHICAGO, ILL.

**"Kewanee" the Ideal Union for Close Work**



**"M and F" pattern. Sectional view.**

There can be no better union for close work than the "Kewanee"—male and female. No nipples are necessary. Connection is made direct with the Union's male end. Fewer joints are needed—less liability of leaks. Fewer connections are made—a saving in labor. No gaskets are required—a saving in material and labor. The "Kewanee" has only 3 parts. It has a ball-joint seat, brass-to-iron contact, and also thread connection. Consequently it never rusts or corrodes. It stands the air pressure test. Send for sample for test and examination.

**NATIONAL TUBE COMPANY,**
**Pittsburg, Pa.**

DISTRICT SALES OFFICES

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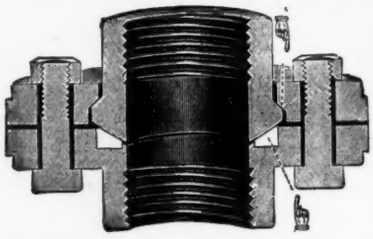
**HILL PUBLISHING COMPANY,**
**505 PEARL ST., NEW YORK.**

## To Make A Never-Leak Joint Use The Jefferson Union



It is made of malleable iron, is consequently strong, has exactly the right proportion of bronze in the seat, is consequently tight.

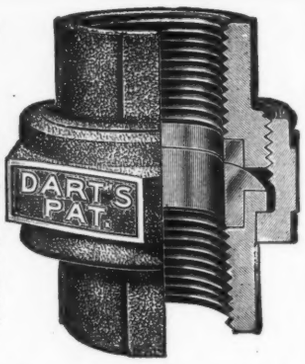
*WRITE FOR THE CATALOG.*

**THE JEFFERSON UNION CO.,**
**31-37 Fletcher Street, Lexington, Mass.**

## Connect Your Pipes

with

## The Dart Union



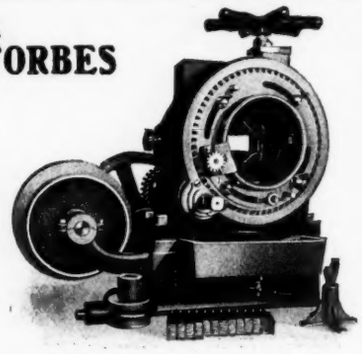

and have immunity from leaks. The bronze seats safeguard against leaks from corrosion, either connected or disconnected. Do you know of any other make of union that you can leave disconnected in a damp place for 24 hours that will not rust unless both sides are rustless?

**E. M. DART MFG. CO., Providence, R. I.**

## One Man With The FORBES

can cut off and thread all sizes of pipe up to 15" by hand. It operates as well in cramped quarters as in all out doors.

*Ask for a catalog.*



**The Curtis & Curtis Co.**
**85 Garden St., BRIDGEPORT, CONN.**

## CRANES

For Power Stations and Shops, Coal Storage Hoisting and Conveying Plants.

Electric and Hand. Catalog Free. Electric Traveling Trolley Hoists and Tracks.

New York:—120 Liberty St.
Philadelphia:—Land Title Bldg.
Chicago:—405 Monadnock Blk.

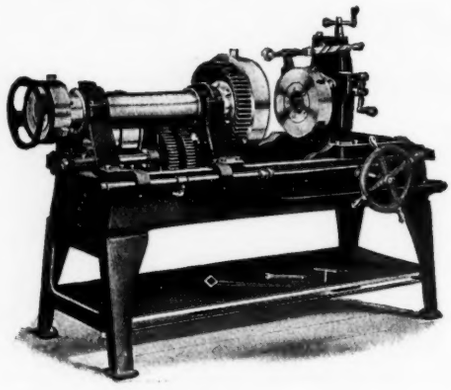
**NORTHERN ENGINEERING WORKS,**
**5 Chene St., Detroit, Mich., U.S.A.**

The man who knows valve values buys

## CHAPMAN VALVES

The difference in value is much greater than the difference in price. *Write.*

**Chapman Valve Mfg. Company**
**Indian Orchard, Mass.**



## GOOD THREADS

may not be an absolute necessity if you use plenty of cement, yet there is no denying the fact that it is *better* to have *good* threads. Some may be satisfied with poor threads, but if you are a sticker for good ones, do your threading on a B. & K. PIPE MACHINE. *Yours for good threads.*

**Bignall & Keeler Mfg. Co.**
**Edwardsville, Ill.**

Threading an 8-inch Pipe Bend with a No. 3 "Toledo."

## Why "TOLEDO" Pipe Threading Devices are constantly growing in favor.

1—They thread pipe easier than others.
2—They are light and therefore portable.
3—They are mechanically right.
4—They are the essence of simplicity.
5—They are strong and of the best obtainable materials.
6—They are inexpensive as compared with other tools not so good.
7—They are furnished with a set of dies for each size pipe, thus giving many times more die service than tools, using one set of dies for several sizes.
8—The dies are simple, and do not require a die-maker to keep them in good condition.
9—The dies are less expensive than others.
10—There are over 30,000 satisfied users.

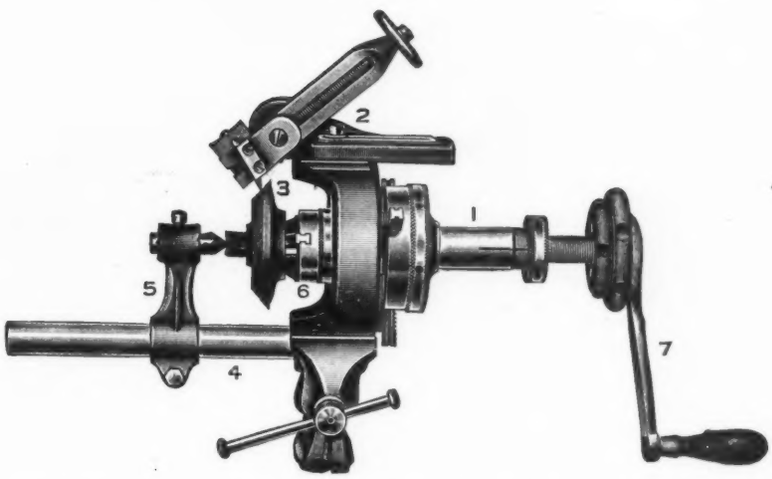
***Write us and we'll tell you more about them.***

**THE TOLEDO PIPE THREADING MACHINE CO.,**
**TOLEDO, OHIO.**

# A VALVE LIKE A CAT

## HAS NINE LIVES

### IF YOU USE




"M & D" machine cutting a Taper disc. Tool can be adjusted to cut a flat or oval disc.

## A Dexter Valve Reseating Machine

Every valve you buy can be reseated from eight to ten times without breaking the steam connections, thus at each time making a brand new valve.

Your scrap heap may contain enough old discarded valves to pay for a Dexter in one day's service.

We will lend you this machine for 30 days' trial and unless you are satisfied that our claims are true it will not cost you one cent even for returning the machine.

*Catalog "P" describes. Get a copy.*

## The Leavitt Machine Company

**ORANGE, MASS., U. S. A.**

## Erwood Swing Gate Valves
## Manganesite Paste for Joints

**WALCH & WYETH, 87 Lake St., Chicago.**

## An Accurate Steam Gage

is as necessary in the boiler room as the clock is in the office. The Ashton Improved Steam Gage registers the boiler pressure far more accurately than the average clock keeps time. *Catalog "P"?*

**THE ASHTON VALVE COMPANY, Boston, U.S.A.**
NEW YORK St. John's House, London, Eng. CHICAGO

## Are You Interested in Floats? Then Stop and Consider

**Hercules Seamless Copper Floats**

They are in reality the only kind worth considering. We originated Seamless Copper Floats and have a host of followers but no equals.

**Hercules Seamless Copper Floats**

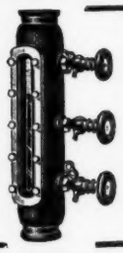
We guarantee all our floats to be perfect in every particular and will replace any inside one year that do not make good.

When over 200,000 have been sold in the past 12 years it means something. Get our Catalog "B"—what's your address?

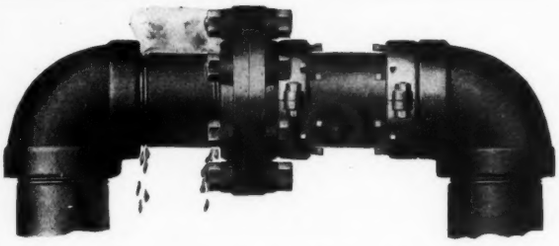
**HERCULES FLOAT WORKS**
P.O. Box 396 SPRINGFIELD, MASS.

## Cold Air And High Pressure

will not break the Reliable Water Gauge. It is made of oxidized brass and unbreakable glass. Lasts as long as the boiler. Circular?



**Reliable Water Gauge Company**
1616A Pine St., St. Louis, Mo.



## The Simplex Pipe Clamp

absolutely guaranteed to make the worst leaky joint permanently tight—sent on 30 days' free trial.

**THE SIMPLEX ENGINEERING CO.,**
316 Preston Street, PHILADELPHIA, PA.

## 60 Cents a Sample Box

and after you have tried the Gilbert Gauge Glass Preserver you'll never use the kind that requires tools again.

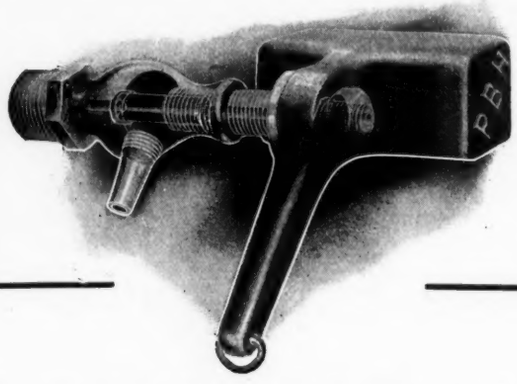
*CIRCULAR?*

**R. F. MORSE**
**Providence, R. I.**

## Free Your Boiler From Drizzle and Dirt

by putting on the **"P.B.H." Weight Gauge Cock.** It is guaranteed *leakless* and has but *one* renewable part, the special metal valve pencil. This is of lasting quality, can be worn right down to the stem and then instantly replaced at the cost of a few cents.

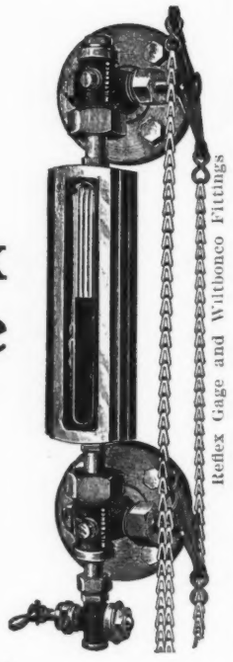
Try it under your own conditions for 30 days. If you don't want it send it back. You can't lose.




**The Paul B. Huyette Company, Inc.**
**2025 Betz Building, Philadelphia**

## Get It In Black and White

then you can not make any mistake and you may at a trifling expense prevent an accident that would cost thousands of dollars and perhaps human lives.



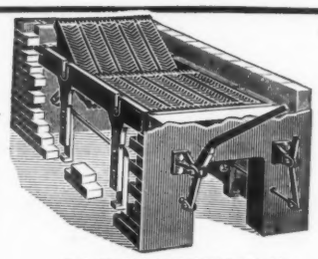
Reflex Gage and Wiltbonco Fittings

# The Reflex Water Gage

is used by all the great navies of the world because it is safe, easy to clean, unaffected by cold drafts of air and will stand the highest pressures. **The Water Shows Black.**

*CATALOG?*

**JERGUSON MFG. COMPANY,**
**219 Columbus Ave., Boston, Mass.**



SALAMANDER DUMPING GRATE.

ROGERS GRATE.

Any draft openings desired, from ¼ inch up. Made for both square and round furnaces. Commends itself on sight. Perfect combustion—long life—low price.

## Satisfactory Results from Cheap Fuel

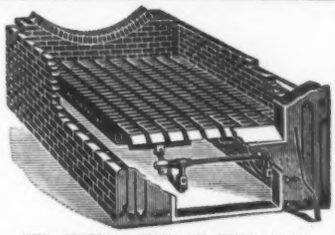
are obtained if your grate is properly designed and constructed.
We are grate experts and have been solving grate questions for over a half century—let us help you.

*Ask for our Book of Grates.*

**SALAMANDER GRATE BAR CO.**

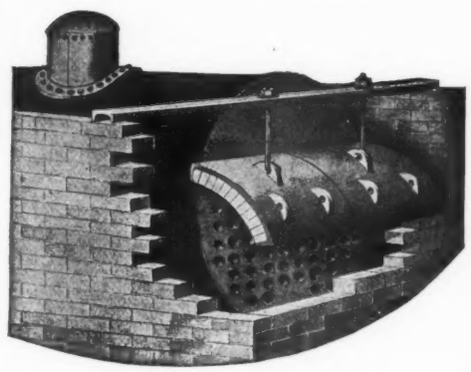
Telephone, 4136 Cortlandt.

**126 LIBERTY ST., NEW YORK.**



THE ORIGINAL ÆTNA SHAKING GRATE.
60 per cent. Air Space

INTERLOCKING GRATE BAR.
Old Reliable. Used in more than 10,000 Furnaces.



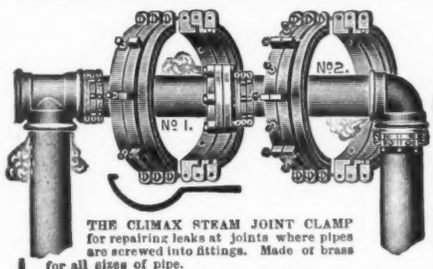
## Don't Crowd

**out the brickwork back of your boiler**

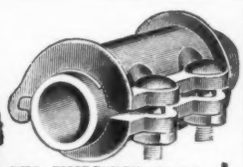
## THE MONARCH BOILER ARCH

is a metal form faced with fire brick and arranged to hang from above. It is easy to set, remove and reset. Your money back if you don't like it. Booklet ?

**MAYVILLE SPECIALTY MFG. COMPANY**
**General Founders and Machinists**
**Mayville, Wis.**




THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.



THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

## PIPE REPAIRS FOR ANY CONDITION

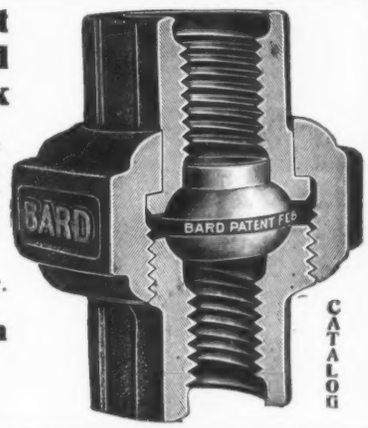
Send for Catalog of
**STEAM SPECIALTIES**
**JAMES McCREA & CO.,**
MANUFACTURERS,
**61 West Washington Street, Chicago.**

## You Can Rest When the Bard Goes to Work

Bard Unions are the best for use and the only unions really practical for repeated reuse.

*Note the reversed ends.*

**The Bard Union Company,**
Incorporated,
**Norwich, Conn.**




# ANNOUNCEMENT---AND AN INVITATION

WE have purchased the great stock and business of the firm of Kelly-Maus & Co., Chicago. And July 1st this old established business became our own.

¶ To the customers of Kelly-Maus & Company we extend cordial greetings and a hearty welcome to the larger business into which their old source of supply has been merged, and we offer better facilities for executing their orders with *instant promptness* from a stock many fold larger and more varied.

¶ To our own patrons, this merger also means much, and it is a source of much satisfaction and pleasure to feel that this enrichment of our stock and enlargement of our business will enable us to serve them better than ever before.

¶ The new SCULLY BLUE BOOK tells the whole story and offers the most complete line of raw and semi-finished materials, as well as supplies for every class of worker in iron and steel, that has ever been assembled under one management in the industrial history of the world. The book is free—may we send it ?

Yours sincerely,

**SCULLY STEEL & IRON CO.,**
**CHICAGO**

By this merger the CHICAGO IRON STORE, Randolph St. Bridge, takes over the old Kelly-Maus stock of Horseshoers', Wagonmakers' and Blacksmiths' Supplies. This stock is also subject to the call of the customers of Scully Steel & Iron Co.

**The Way To Save Fuel Is To Burn All You Stoke**

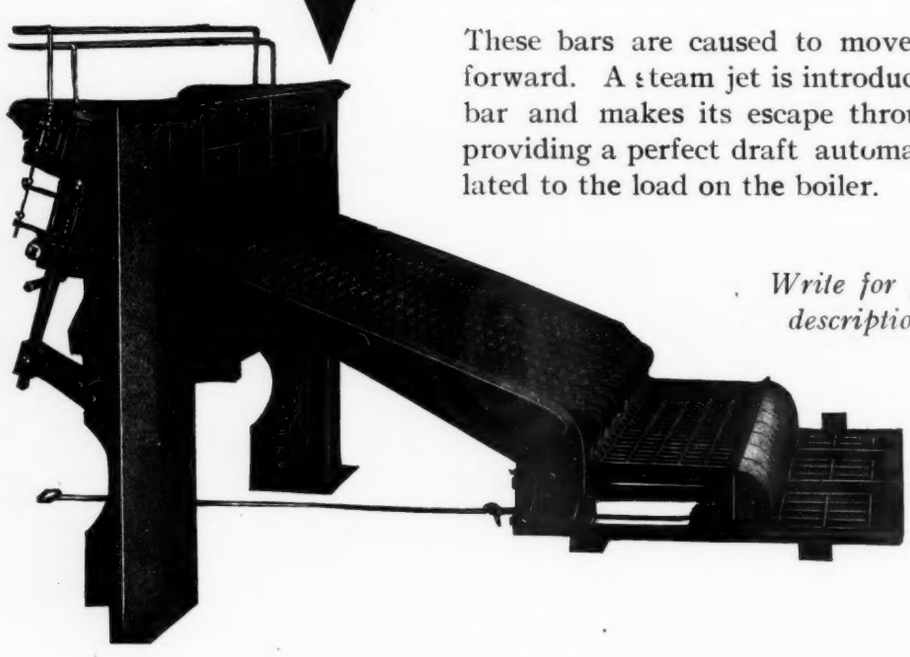
# Operation of the WILKINSON Automatic Stoker and Smoke Preventer

The fuel, crushed or slack coal, is fed into a hopper from which it is mechanically forced under a kindling arch and down the easy incline of the grate.

Thus it passed through various zones of combustion till it rests on the ash table where it burns out completely and falls over into the ash pit.

The grate consists of hollow bars, stepped and set very close together.

These bars are caused to move alternately forward. A steam jet is introduced into each bar and makes its escape through the fire, providing a perfect draft automatically regulated to the load on the boiler.

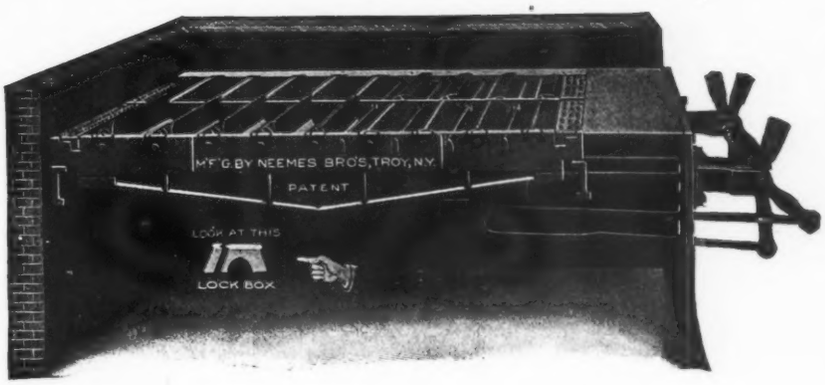


*Write for full description.*

**THE WILKINSON MFG. CO.,**

**BRIDGEPORT, PA., U. S. A.**

# These Clinker Cutting Shaking And Dumping Grates




secure perfect combustion by cutting from both sides of the shaker alike.

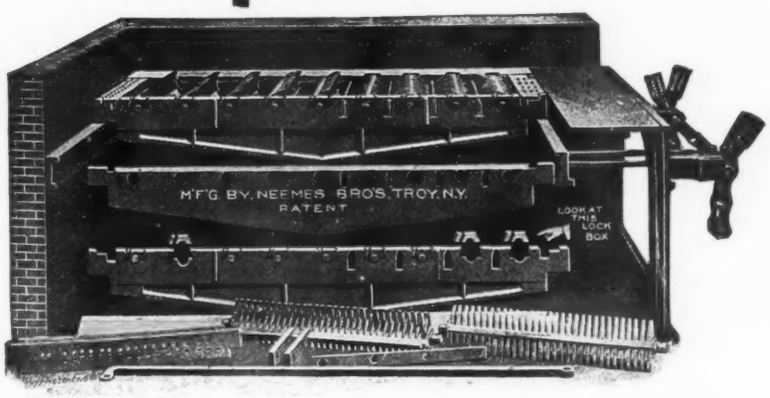
This exclusive feature of the

## Neemes Brothers Improved Grates

with the Shear Cutting Shaking Grate Front and Shaking and Dumping Grate Back reduces fuel cost at the same time increasing their steaming capacity and greatly adding to the convenience of its operation.

A slight oscillation of the lever shakes out the ashes—a full opening and a shake or two dumps everything to the ashpit.

*Write for full details.*




## NEEMES BROTHERS,

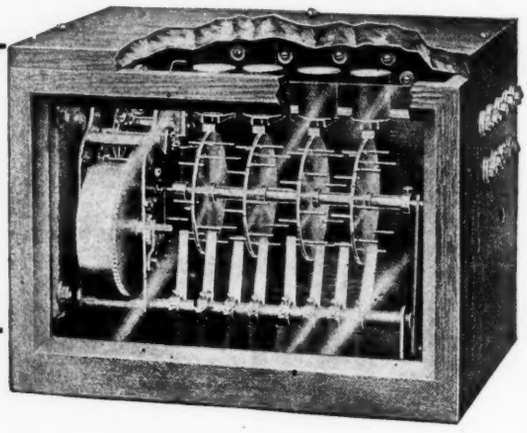
**41-49 Adams St.,**

**Troy, New York.**

*MANUFACTURERS OF SQUARE AND ROUND GRATES*

C. W. Van Blarcom, Hudson Terminal Bldg., No. 30 Church St., Agent for New York City and vicinity. Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 311 Industrial Building, Providence, R. I. Sole Agents for the New England States. Cass Harkins, Hayden Building, Columbus, Ohio.

## No Unburned Fuel Escapes
### Where The Air Supply Is Right

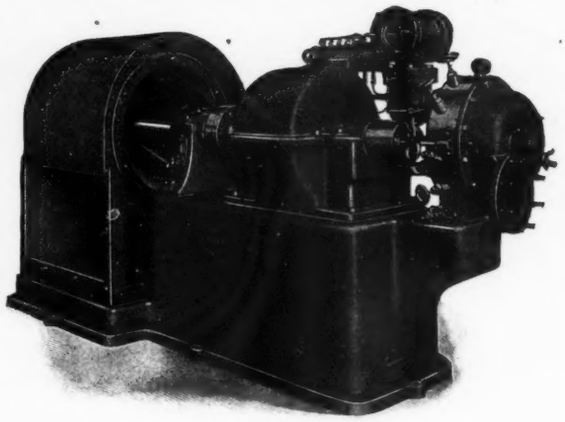


Our New Automatic Smoke Preventing Device is simply constructed, positive in action, and absolutely independent of the fireman. It regulates the air supply perfectly. Perfect results or no pay. Write for details.

**Climax Smoke Preventer Co.,**
205 Equitable Bldg., Boston, Mass.

## "SIROCCO"
TRADE MARK

## BLOWERS
BUILT ON THE TURBINE PRINCIPLE
MOST EFFICIENT FOR ALL DUTIES



**STEAM TURBINE UNIT**

20" Double Inlet Sirocco Blower, Direct connected to a steam turbine for forced draft. Capacity of 28,000 cu. ft. against a pressure of 5½" water gauge. EFFICIENCY 65%.

**SIROCCO ENGINEERING CO.**
138-140 Cedar St., New York. Works: Troy, N. Y.

## Your Grate Is The Real Foundation of Your Success

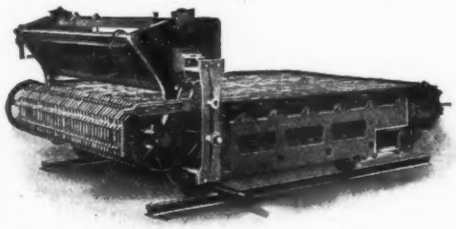
Why build on an unreliable foundation when the trifling difference in cost would be repaid numberless times by

### The Martin Anti-Friction Rocking Grate

These grates can be installed without alteration of the fire box and they get from second rate fuel the results you would expect from the very best.

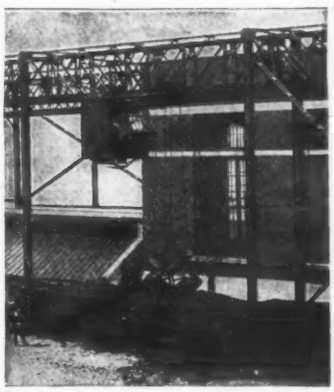
## THE MARTIN GRATE COMPANY
281 Dearborn Street Chicago, Ill.

**GREEN TRAVELING LINK GRATES**



Highest Capacity
Highest Efficiency
Automatic
Smokeless
Labor Saving
Cheap Fuel

**GREEN ENGINEERING CO.**
Main Office: Commercial National Bank Bldg., Chicago, Ill.
Branch Offices: Pittsburg : St. Louis : St. Paul : Louisville
**General Foundry Work a Specialty**

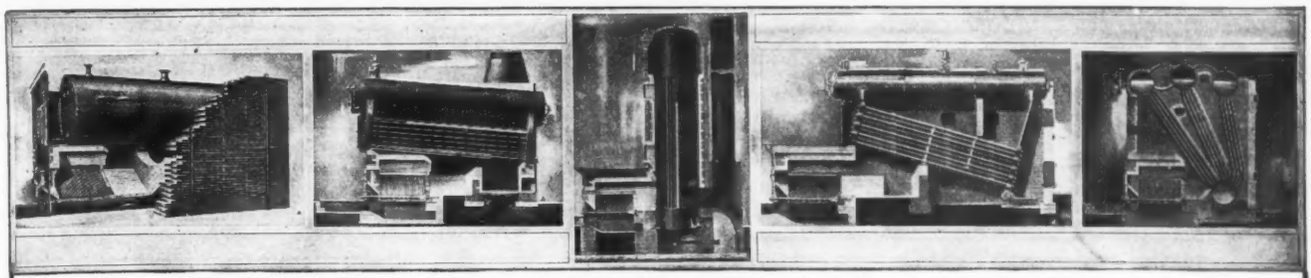


**JEFFREY**
Grab Bucket Hoists
**Pivoted Bucket Conveyors, Etc.**
For Handling
**Coal and Ashes**

Elevators, Conveyors, Crushers, Screens, etc.

The Jeffrey Mfg. Co.
Columbia, Ohio, U. S. A.

New York. Chicago. Boston. Pittsburg. Denver
Charleston. Knoxville. St. Louis. Montreal.



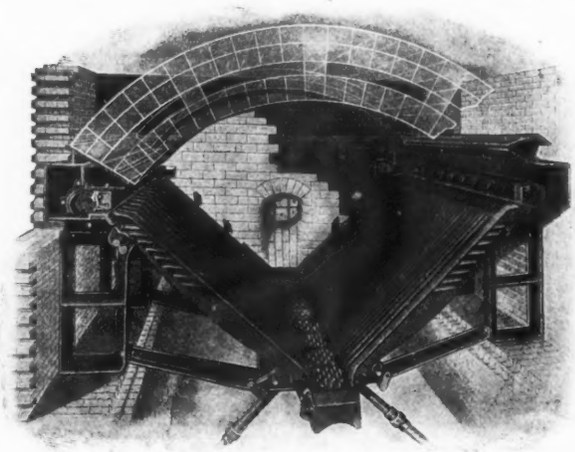
Any type of boiler.

**The Murphy Automatic Smokeless Furnace**

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

**Murphy Iron Works, 5 Walker Street, Detroit, Mich.**

Units of any size.



**"The most economical method for Burning fuel in Power Plants."**

**Detroit Automatic Stoker**

It burns all kinds of coal economically, reducing the fuel bill 10 to 25%.
It adds to the steaming capacity without injury to the boiler shell or tubes.
It feeds and burns the coal and cleans the fires with closed doors.
It insures uniform furnace temperature by continuous, positive feed for fuel.
It does all this with a SMOKELESS STACK.

*SEND FOR CATALOG.*

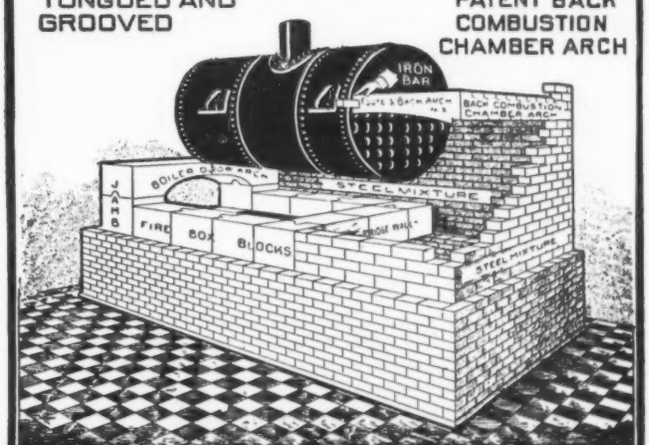
**DETROIT STOKER & FOUNDRY CO.**
**DETROIT, MICH.**

**"STEEL MIXTURE"**

**BOILER DOOR ARCHES AND FIRE BOX BLOCKS**

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH




MANUFACTURED BY
**McLEOD & HENRY CO.**
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

Buffalo Electric "B" Volume Exhauster Showing Motor Side.

# Buffalo "B" Volume Exhausters

**For either Blowing or Exhausting**

When asking for prices of electric blowers or exhausters state clearly for what purpose the fan is to be employed, and give the voltage of the current available.

*Catalog PR on Request.*

## Buffalo Forge Company

**Buffalo, N. Y.**

**Canadian Buffalo Forge Co., Ltd., Montreal, Canada**

Planing Mill Exhaust Fans for Smoke and Shavings Exhaust Purposes. F-27 Buffalo Disc Wheels, Pulleys, Steam and Electric Types.

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CONTRACTORS.
CENTRAL STATION HEATING.

Write for valuable information.

**AMERICAN DISTRICT STEAM CO.,**
**Lockport, N. Y. Toronto, Can. Chicago.**

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YOU will not have scale if you use the ADVANCE FEED WATER PURIFIER and you will not have to pay for the ADVANCE unless you like it after the trial. Write.

F. E. KEYES & SON, 20 Broad St., New York

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# Wing's Turbine Blower

FOR FORCED DRAFT

Most Efficient Most Compact Catalog?

L. J. WING MFG. CO., 90 West Street, NEW YORK

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GOES IMPROVED COMBUSTION AND DRAFT SYSTEM

**GEO. H. THACHER & CO.,**
**ALBANY, N. Y.**

GRATES OF ALL KINDS. BOILER CASTINGS.

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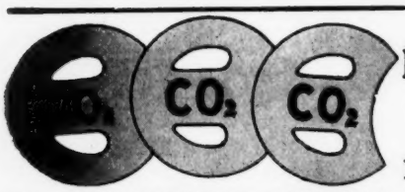


C-O-Two Tile
**FIRE ARCHES**
Any Rise, Any Span,
Air Baffle Mixing System
produces
**RESULTS**

C-O-TWO FURNACE COMPANY, Syracuse, N. Y.

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U.S. METAL POLISH
G. W. Hoffman, Sole Prop. 295 E. Wash. St.
INDIANAPOLIS, IND.
TRADE MARK.
INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:
Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth.

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## Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

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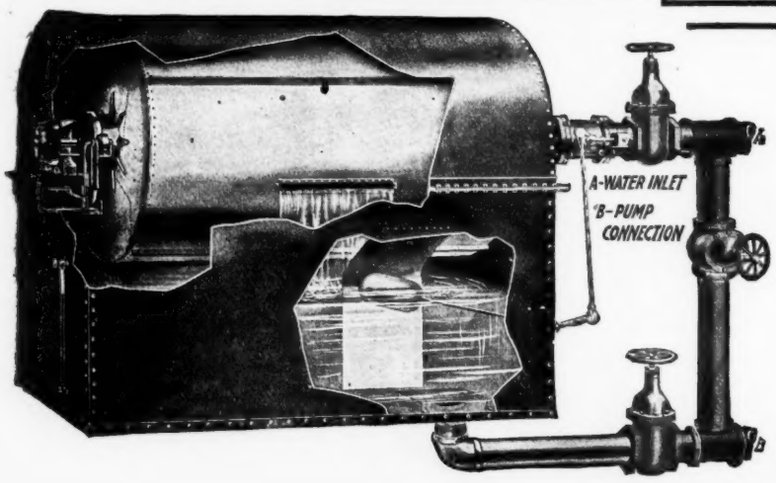



## What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
**Can You Tell Your Evaporation?**
A

## DETROIT METER

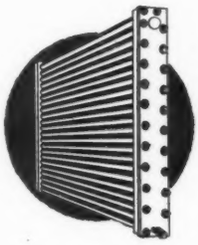
**Will Give You a Continuous Record of Your Boiler Feed Water**

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

**CENTRAL STATION STEAM COMPANY**
**Detroit, Mich., U. S. A.**

*SEND FOR CATALOG.*

# A Rationally Designed Heater



for transmitting heat from live or exhaust steam or hot water to air or for abstracting heat from the air by means of cold water, should possess certain features.

First, it should be efficient, that is, it should transmit the greatest possible amount of heat per square foot of surface. In the Green Patent Heater this has been secured by using many small pipes and by so arranging them that the steam must flow through at a good velocity without possibility of water-logging or air-binding. The steam or water distribution is positive or uniform. Some heaters have the pipes arranged in U-shaped sections which are of unequal length and, moreover, the circulation of steam is not positive, as in these heaters steam can pass directly from the inlet to the outlet without going through the pipes. In the Green Heater all the tubes are of the same length and the steam or water must pass through them all in order to get out. Drainage is perfect.

Second, the heater should be easy to get at for inspection or cleaning. In the Green Heater this has been insured by the use of straight tubes expanded into headers. By removing the covers, the interior of every tube is visible from end to end and the cleaner can easily be run through to take out oil deposited by exhaust steam or scale deposited by water.

Third, a heater should be easily kept tight and should be uninjured by expansion and contraction. We have secured this by avoiding the use of elbows and screw joints, which cannot help but be loosened by unequal expansion. All the pipes of the Green Heater expand parallel and equally.

When we put in a Green Heater we do not guarantee simply so many square feet of surface; we guarantee that with given temperatures a certain amount of heat will be transmitted, which is really all that you care about or want. The Green Heater enables you to get the most transmission at the least cost.

Write for our booklet "P 101" and for estimates and prices on a given case and see if this is not so. Ask also for our Heating, Ventilating and Drying Booklets.

**The Green Fuel Economizer Co.,**
**MATTEAWAN, N. Y.**

New York City Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal

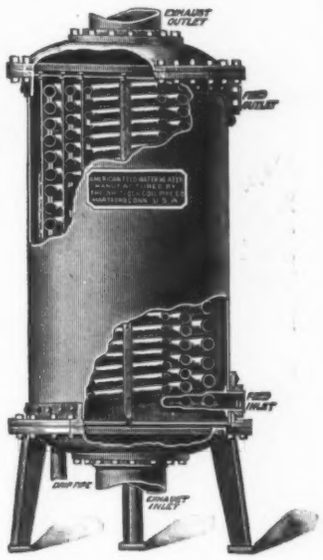
Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 153

# The American Standard Copper Coil Feed-Water Heater

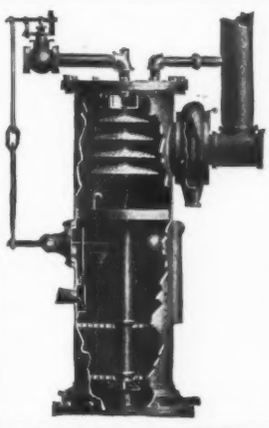
**represents the highest type of feed-water heating apparatus and should always be used where the highest temperature and most satisfactory results are desired.**

**It costs no more than less efficient types.**

**It is the simplest and most widely used type of heater in the market today.**




Manufactured by
**The Whitlock Coil Pipe Company**
**Hartford, Conn.**
**New York Office, Singer Bldg., 85 Liberty St.**



# OUR TWINS

EITHER ONE WILL SAVE 15% of fuel and preserve the boiler.

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Branch Office:
136 Liberty St., New York,
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# Efficient Durable Accessible

**Patterson-Berryman Heater and Purifer**

is sold on trial and guaranteed satisfactory or your money back.

*Write today.*

**Frank L. Patterson & Co.**
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## Nearly Three Million

H. P. in daily use, saving thousands of dollars in coal and boiler repairs.

# The National Feed Water Heater

is the simplest in design, the most economical in repair costs and requires the least attention of any feed water heater ever designed.

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**The National Pipe Bending Co.,**
**168 River St., New Haven, Conn.**

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## No Dirt Settles Around The Tubes

because the tube sheet of the

**OTIS TUBULAR FEED WATER HEATER**

is pitched like a roof and the dirt slips off and falls to the cool settling chamber, from which it is easily blown off.

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## KOERTING
## Continuous Water Heater Condenser and Exhauster

This apparatus is intended for the direct application of steam to water heating, while flowing through pipe under pressure.

Also as a Condenser and Exhauster, for heating coils and on the exhaust pipes of engines.

It can be used with steam of any pressure or with exhaust steam, or for the maintenance of a partial vacuum with steam below atmospheric pressure, or as an Exhauster for the removal of air only.

The capacity and range in volume is regulated by the central hand wheel, and when used for heating water its temperature is regulated by throttling with a valve in the steam pipe.

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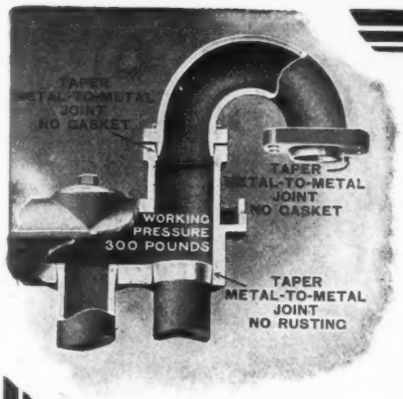


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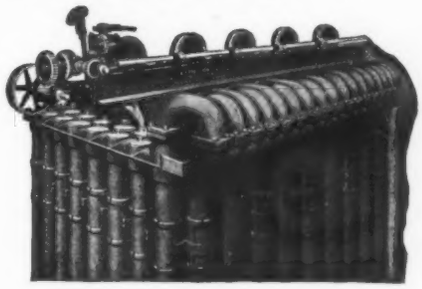

## METAL-TO-METAL IS THE STURTEVANT

## B. F. STURTEVANT CO., Boston, Mass.

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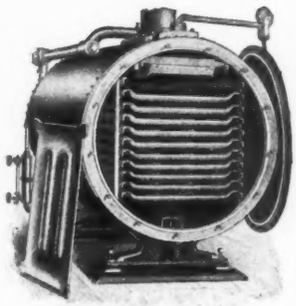
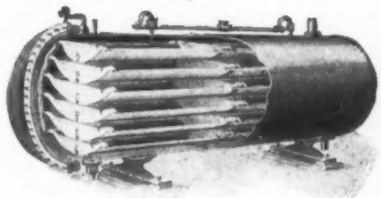
Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters, Rotary Blowers and Exhausters; Steam Engines, Steam Turbines, Electric Motors and Generating Sets; Dust Collectors, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, Steam Turbines, etc. 689

# HOPPES



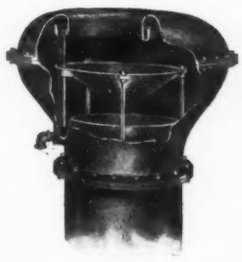
Feed-Water Heater—Class "R"

Exhaust Steam Feed-Water Heaters, Live Steam Feed-Water Purifiers, Steam Separators, Oil Eliminators, and Cast-Iron Exhaust Heads.

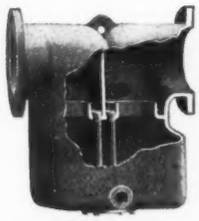


Live Steam Feed-Water Purifier

## STEAM SPECIALTIES



Exhaust Head



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Every machine guaranteed in every respect. Our prices are right.

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## The Steam Jacket Feed Water Heater.

The steam enters the bottom, passes up through the tubes and returns down the annular space between the inner shell and the jacket; thus preventing all radiation, and insuring a higher degree of heat than could be obtained in any other way.

Over 5000 of these heaters are now in use, some of them having been in service since 1877.

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Thos. B. Whitted, Piedmond Bldg., N. C., Southeastern Manager.

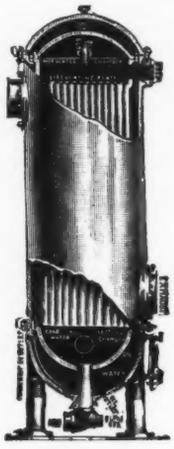
## Easy to Buy, Install, Operate, Clean or Repair

and guaranteed to maintain its maximum rated capacity.

## The Riblet Feed Water Heater

will protect your boiler from expansion and contraction troubles, save fuel and increase power.

*Catalog ?*



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**No Accident Can Disable**
THE
## REILLY MULTICOIL HEATER
**for more than a few moments**

The engineer by himself can remove and replace any coil—needs only a wrench. All tube connections by standard screwed ground union joints. All accessible through the door in the shell.

**Every Coil a Spring—No Leaks.**

**Coils will not accumulate scale** and heater needs no labor of cleaning. This is a fact—if you write us to ask the reason we will show you.

Used by U. S. Govt. Departments because of its efficiency.

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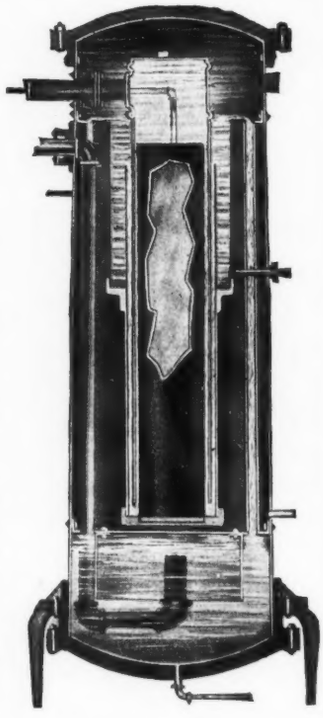
**Boilers---Engines---Tanks---Stacks---Plant Supplies.**

## Save Two Dollars Per Year Per H. P.

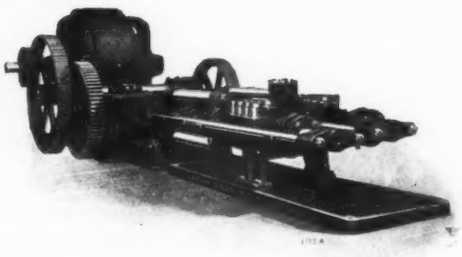
by eliminating scale formation, unequal contraction and expansion, and saving the amount of coal now required to raise feed water to the steaming point.

All this is easy with the Eclipse Feed Water Heater and Purifier. WRITE.

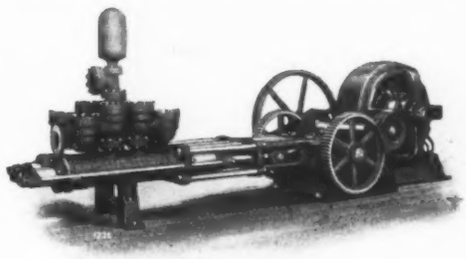


**The Eclipse Feed Water Heater and Purifier Company,**
OSHKOSH, WISCONSIN.

# DEAN BROS. POWER PUMPS



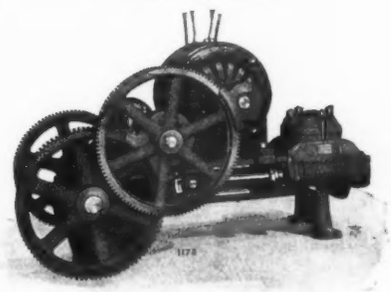
DEAN BROS. Duplex Hydraulic Pump
Electrically Driven



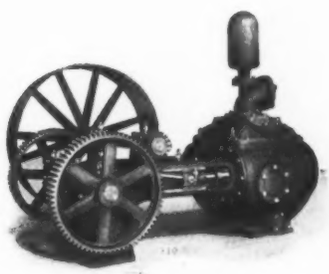
DEAN BROS. Duplex Plunger Pump
Outside End Packed Type
Valve Pot Pattern, Electrically Driven

DEAN BROS. Duplex Plunger Pump
Outside Center Packed Type
Electrically Driven

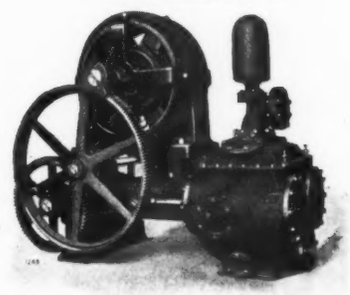
DEAN BROS. Duplex Piston Pump
Electrically Driven



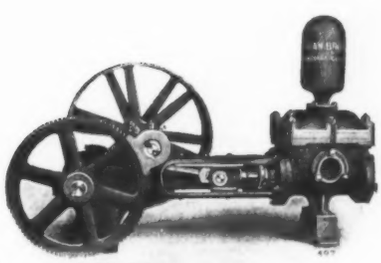
DEAN BROS Duplex Piston Pump
Electrically Driven



DEAN BROS. Duplex Piston Pump
Belt Driven



DEAN BROS. Duplex Piston Pump
Electrically Driven



DEAN BROS Single Piston Pump
Belt Driven

DEAN BROS. have special catalogues which they will furnish illustrating their various types. They solicit correspondence with those in need of pumping machinery. DEAN BROS. condensers are of the latest type and highest grade.

DEAN BROS. manufacture and carry in stock a full line of STEAM driven pumping machinery.

## DEAN BROS. STEAM PUMP WORKS,

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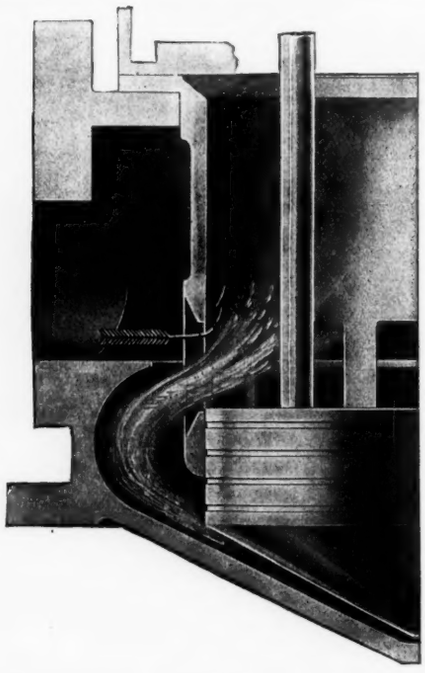

## Speed of Water Corresponds to Speed of Pump in the Wheeler-Edwards Patent Air Pump

The speed of the water must correspond to the speed of the bucket, moreover the water has nearly a whole revolution during which to gravitate into the conical cylinder bottom. It is then mechanically driven by the plunger around into the pump chamber and is carried up by the piston on the return stroke. As there are no foot valves and no water seals, the entire difference of pressure between the pump and condenser acts to deliver air and vapor to the pump.

Further, there are no bucket valves. The bucket valves of other pumps, especially of the vertical pattern, are often compelled to handle the whole column of water within a very short interval of time, subjecting them to serious wear and the possibility of breakage.

The Wheeler-Edwards Patent Air Pump gives a vacuum of ½ to 1 inch higher than the old style pumps and will even equal or exceed the troublesome and costly dry vacuum pumps with separate hot-well pumps and air coolers.

We have patterns on hand for steam, belt and electrically driven pumps and for pumps to be driven from the cross-head or the tail-rod of the main engine.

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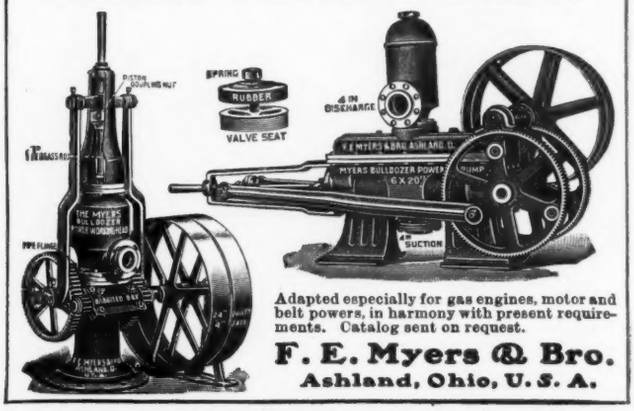
## MYERS POWER PUMPS.




Adapted especially for gas engines, motor and belt powers, in harmony with present requirements. Catalog sent on request.

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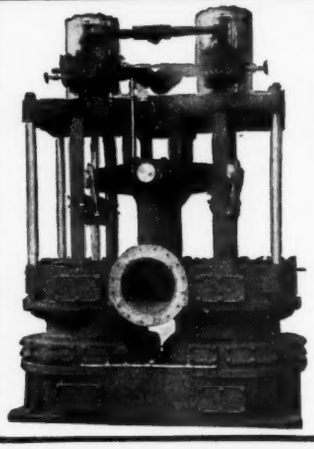
**Ashland, Ohio, U. S. A.**



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**Warren, Mass.**

**PUMPS FOR ALL REQUIREMENTS**

PISTON—PLUNGER
HYDRAULIC DEEP WELL
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Air Pumps and Jet Condensers Combined.
Air, Circulating and Marine.
Duplex Vertical Air Pump and Jet Condenser.
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Centrifugal
Barometric

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Heaters
Generators
Expansion Joints

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A NEW DEPARTURE

All Forged Steel
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**The Movable Jaw Extends Outward Instead of Toward the Handle, Therefore**

**The Larger the Nut the Longer the Leverage**

THREADS IN BOTH NUT AND JAW ARE ROUNDED THUS PREVENTING STRIPPING

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## Prescott Condensing Apparatus

*Complete Line for Power Plants.*

Boiler Feed and General Service Pumps for all conditions.

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Milwaukee, Wis.

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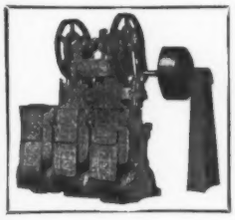

For any service. **Power**

For operation by any power. **Pumps**

**The Deming Company**

Agencies in Principal Cities

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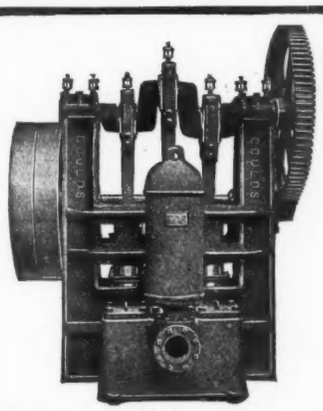

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Built in the best manner and of material that can be depended upon. They will be found to fully sustain the high reputation of

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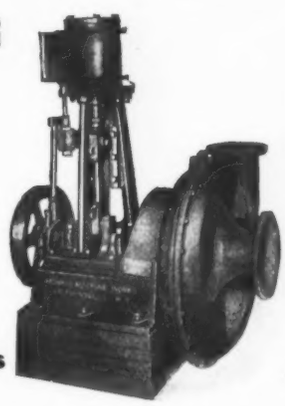
Built with a knowledge gained in 40 years of successful pump building, we make these pumps for every possible service.



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## Do you want a high duty air pump that won't stop? Made in two styles—single, for engine work—two stage, for turbine work.

The air pump is operated by a Corliss engine with variable speed control. Engine and air pump both accessible for cleaning and adjustment without taking down.

| New Corliss Engines for Immediate Delivery | | Corliss Engines for 30 Days Delivery | |
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| 1 10x24, | 50 H. P. | 2 10x24, | 50 H. P. |
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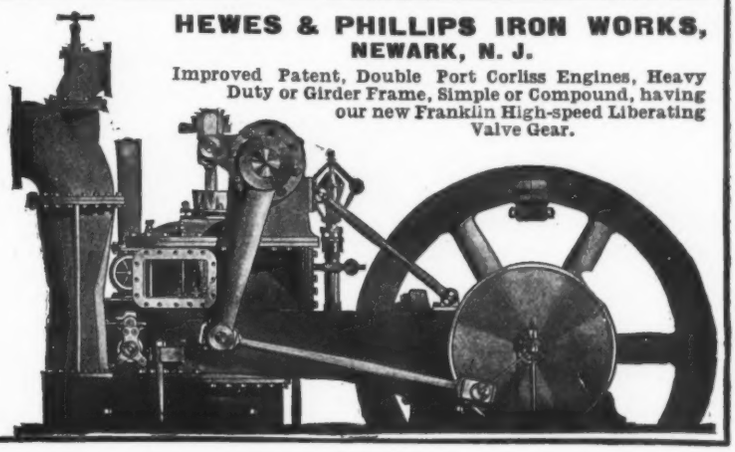
Improved Patent, Double Port Corliss Engines, Heavy Duty or Girder Frame, Simple or Compound, having our new Franklin High-speed Liberating Valve Gear.



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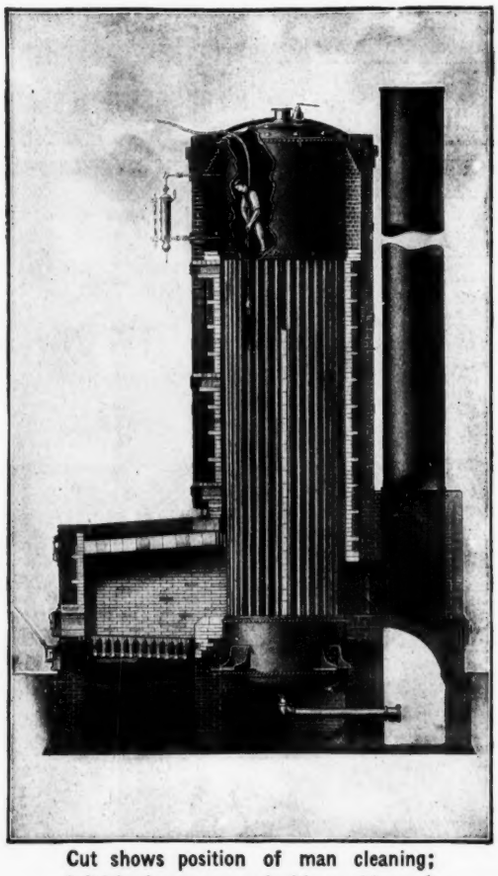
## Vertical Water Tube

Ever cleaned a boiler? Know how hard it is? If you have you will appreciate this boiler at a glance.



Cut shows position of man cleaning; Is it laborious compared with usual forms?

Two 12″ x 16″ manholes open the Wickes Vertical Water Tube Safety Steam Boiler from top to bottom for inspection and cleaning. Every tube can be looked through; every tube washed or scraped.

**Safe.**

**Low cost of maintenance.**

**High furnace and heat abstracting efficiency.**

**Absolutely dry steam.**

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Magnesia, Asbestos, Air Cell,
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*Estimates given and work executed promptly.*

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Guaranteed to form the best Vacuum by head of water or by supply pump

## The Bulkley Injector Condenser

In general use on all classes of engines.

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☞ YOUR LOSS IF YOU DON'T KNOW US.

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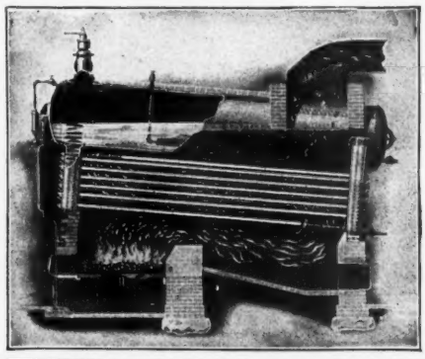

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**AND SUPERHEATERS**

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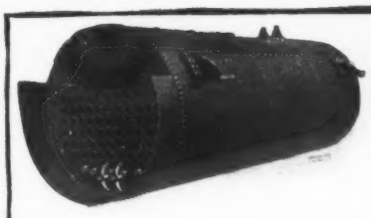

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**Are Boilers of CHARACTER**

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

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**STEAM SUPERHEATERS—MECHANICAL STOKERS**

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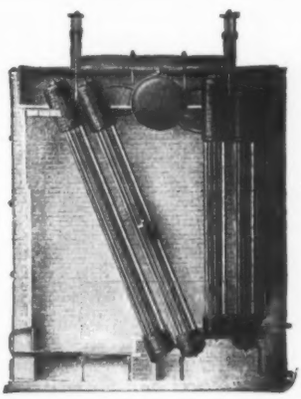
## The Bigelow-Hornsby Water Tube Boiler

UNLIMITED SIZE OF UNITS, 2,500 HORSE POWER OR MORE.
COLDEST WATER MEETS THE COLDEST GASES.
DIRECT HEATING SURFACE ABOUT FOUR TIMES AS GREAT AS THE AVERAGE WATER TUBE BOILER.
ALL PARTS, BOTH EXTERNAL AND INTERNAL, READILY ACCESSIBLE.
ALL BOILER TUBES PERFECTLY STRAIGHT.

*Large well Illustrated Catalog on request.*



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*Vulcanizers, dryers, foundry cupolas, tanks, stacks and special work.*

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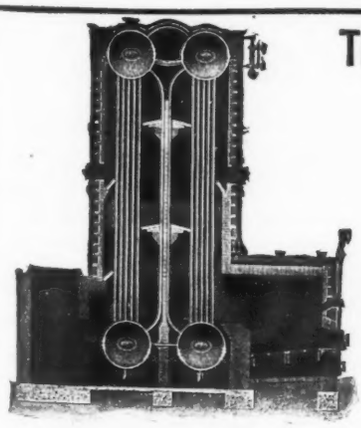
## THE RUST WATER TUBE BOILER

**Safe**
**Simple**
**Economical**
**Durable**
**Accessible**



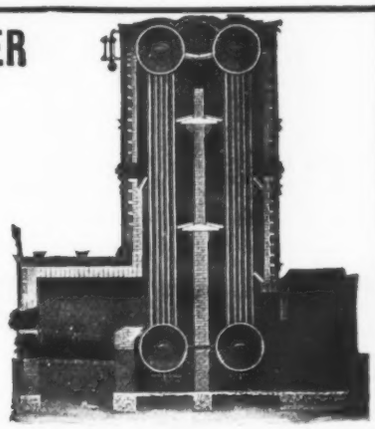
Type B

**THE RUST BOILER COMPANY,**

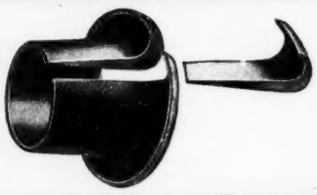
**Pittsburgh, Pa.**

BRANCH OFFICES
New York, 50 Church Street.
Birmingham, Ala., First National Bank Building.

Write for Report of Tests by William Kent.



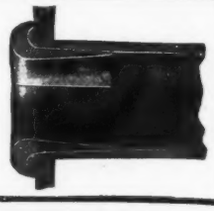
Type O



**New Tubes for Old Ones—** The Work of a Minute

with Cruise Tube Protectors They cost but a trifle, are no trouble to install and make your old tubes as good as new. *Write.*

**CRUISE & CO.,** 144-150 Broadway Elizabeth, N. J. Telephone Nos. 745R—526R

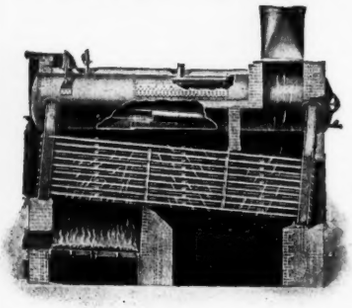


**Parker Boiler Company,** Pennsylvania Building, Philadelphia, Pa.

**PARKER BOILERS**

NEW YORK— 90 West Street.
PITTSBURG— 1806 Machesney Bldg.
CHICAGO— 1519 Marquette Building
DENVER— 1707 Glenarm Street.
SAN FRANCISCO— Main and Folsom Sts.

**Water Tube Boilers**



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ESTABLISHED 1865.

**E. KEELER CO.**
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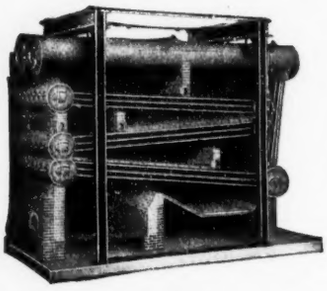
New York, Philadelphia, Chicago, San Francisco, Wilkesbarre and New Orleans.

THE
**Gambria Steel Co.**
Johnstown, Pa.
has equipped its 43,860 H.P. with 206
**MURRAY AUTOMATIC BOILER FEED REGULATORS**
This is but one of the many complete Murray installations in world-famous plants.

*Write for Particulars and Prices*

**Murray Automatic Boiler Feed Company,**
Detroit, Michigan.

**Unequalled in Durability**



Efficiency
Convenience
and Economy
THE VOGT BOILER

*Circular ?*

**Henry Vogt Machine Co., Inc., Louisville, Ky.**

**"Climax" is the Boiler to Install.**

Why not have a boiler that will do its duty thoroughly? That is, a boiler that will get out of coal and water all the steam possible to get and hold its pressure under unfavorable conditions. That's the "Climax." It's the boiler of the present. Shall we send the Catalog?

**The Morrin Climax Boiler Company,** BROOKLYN, N. Y.

Main Office: 240 Lorraine Street. Works: Smith, Lorraine, Court & Creamer Streets.
Telephone, 243 Hamilton.

**The Copes Boiler Feed Regulator** automatically holds the water level at one point and feeds the water as needed. The Copes Pump Governor controls the feed line pressure. *Write for book "P."*

**AMERICAN BOILER ECONOMY CO.,**
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**Foster Superheaters**

Insure economical steam consumption on light loads.

**POWER SPECIALTY CO.,**
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TUBULAR AND WATER TUBE TYPES

**TUDOR BOILERS**

INCORPORATED 1834

The Tudor Boiler Mfg. Co., - Cincinnati, Ohio

TANKS AND STEEL PLATE WORK

## Judge For Yourself
### With A 30 Days' Trial Of
### THE FISHER PUMP GOVERNOR

There are more of them in use than all other kinds combined, that's pretty strong evidence, but a trial is stronger evidence still.

*Write!*

**The FISHER GOVERNOR CO.**
**MARSHALLTOWN, IA.**

## Watson Steam Pump Governor

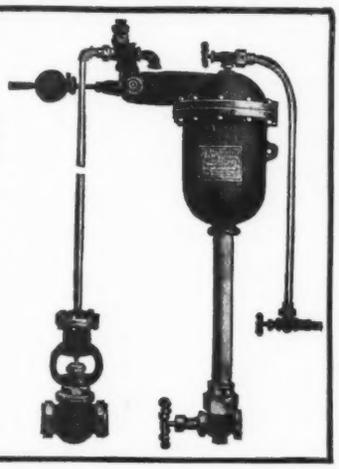
For maintaining an even water pressure. Should be used on all steam pumps where a fixed discharge pressure is desired. Designed right and made right, it is automatic and reliable. Send for catalogue.

**Watson & McDaniel Co.,**
**Philadelphia, Pa.**

## The Vigilant Feed Water Regulator

for Steam Boilers was the first in the field, and has the longest and best record of any of these devices. *Costs less to operate and maintain.* Constructed on a different and better principle than any other. Investigate it and the FULTON PUMP GOVERNOR, and send for latest catalog with list of users. A guarantee from a responsible firm with every machine.

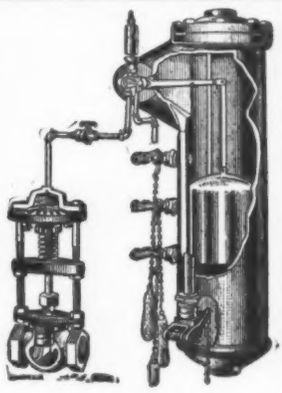
**THE CHAPLIN-FULTON MFG. CO.,**
**PITTSBURG, - PA.**
D. W. Patterson, Agent, Harrison Bld., Philadelphia, Pa,



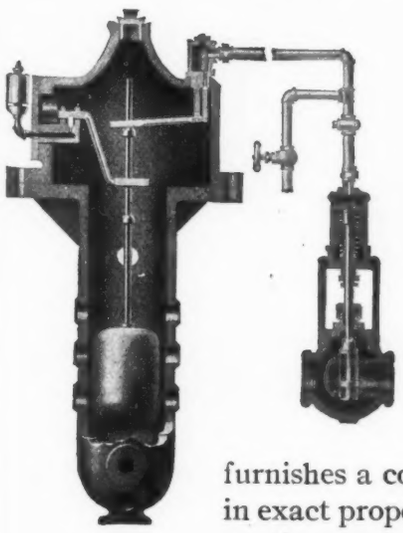
## THE BERRY
Safety Automatic
## Feed Water REGULATOR

**Send for Catalogue**

**BERRY ENGINEERING COMPANY**
**Chester, Penn.**
Canadian Office, Room 16, No. 17 St. John St., Montreal, Canada.



## Maximum Boiler Efficiency



**The Gould Feed Water Regulator**

furnishes a continuous feed in exact proportion to evaporation and eliminates all possibility of dangerous accidents resulting from unstable water level.

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**The Safety Equipment Manufacturing Co.**
**Power Plant Specialists**
**176 E. Lake Street** **CHICAGO, ILL.**

## Here is Another Curtis Specialty

## The Curtis Damper Regulator

is the most simple, durable and economical device on the market. Regulates to any position with the varying steam pressure—no water connection. It is fully up to the standard of other Curtis products.

*IF YOU ARE NOT FAMILIAR WITH THEM WRITE FOR DESCRIPTIVE CATALOG.*

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**24 Canal St., Boston, Mass.**

## Better Light

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**CHEAPER THAN YOU BUY IT FROM THE MAINS**

Produce it yourself with Engberg's Generating Set. Size and power considered there is nothing to equal it on the market. Will maintain with perfect steadiness from 30 to 500 lights requiring very little steam and less of your attention. For compactness and reliability it has no equal.

**Engberg's Electric & Mechanical Works** St. Joseph, Michigan.

1025

## NORTHERN TYPE L GENERATORS.

**SOMETHING NEW.**

Trisected laminated poles which insure perfect commutation and close regulation. Natural system of ventilation which insures low temperature rise.

Other advantages described in detail in bulletin 3355.

**NORTHERN ELECTRICAL MANUFACTURING CO.,**

Standard and Special Electrical Machinery,

MADISON, WISCONSIN.

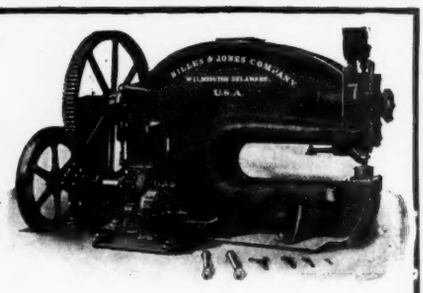
## The Motor

FOR DRIVING HEAVY TOOLS

## C & C

Type "S L" Variable Speed

The connection is made by gearing and the motor is especially wound for the severe work required of it.



For every industrial use a C. & C. MOTOR is a wise choice.

## The C & C Electric Co.

General Office and Works, GARWOOD, N. J.

New York, 149 Broadway. Philadelphia, West End Trust Bldg.

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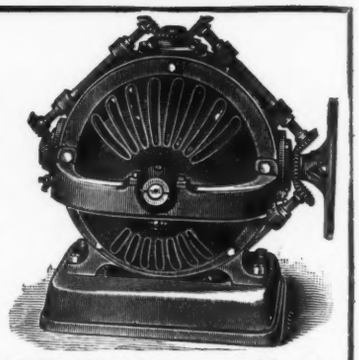
Agencies in all principal cities.

## Self-Contained

The only motor requiring no resistance box is

**The Stow Multi-Speed Motor**

It offers a wide range of speeds without wasting current as the speed is decreased. *Catalog?*



## STOW MFG. COMPANY, Binghamton, N. Y.

GENERAL EUROPEAN AGENTS

Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, England.

**1 to 75 H. P.**

**2 and 3 Phase.**

15 H.P. 220 V. 1200 R.P.M. 3 Phase Motor.

# TRIUMPH

direct current apparatus is known wherever electrical machinery is in use.

**WE** have a new line of Alternating Current Induction Motors which will be just as well and favorably known.

*Your inquiries are solicited. Ask for Bulletin P-321.*

## TRIUMPH ELECTRIC CO.

**Main Office and Works: Cincinnati, O.**

*Branches in all large Cities.*

# A TEST

OF A

## LOOMIS-PETTIBONE GAS PLANT

operating a 500 B. H. P Gas Engine, showed on a 51-hr. run a consumption of but 1.4 lbs. bituminous coal per K.W.-hr.

*Write for particulars to*

## POWER AND MINING MACHINERY COMPANY,

(Owners and Exclusive Builders.)

New York Office, 115 Broadway.

General Offices and Works, MILWAUKEE, WIS.

## OTTO ENGINES

## Gold Medal at Jamestown

OTTO OTTO

The U. S. GOVERNMENT paid this Company a big compliment when it selected the "OTTO" Engine for use in making fuel tests at the Jamestown Exposition.

The Jury of Awards also proved its fitness for its task when it awarded the "*OTTO*" the *GOLD MEDAL.*

The "OTTO" has won *FIRST PRIZE* at every large Exposition held in this Country since the Centennial in '76.

## The Otto Gas Engine Works,

**Philadelphia, Pa.**

STANDARD OF THE WORLD

OVERCOME
YOUR ALIGNMENT TROUBLES!

USE B-M-A
FLEXIBLE LINK COUPLING

The ideal method for connecting prime movers to

GENERATORS, BLOWERS, COMPRESSORS, PUMPS, ETC.

Standard sizes up to 500 H.P., but we design them to meet all conditions and will be pleased to learn of yours.

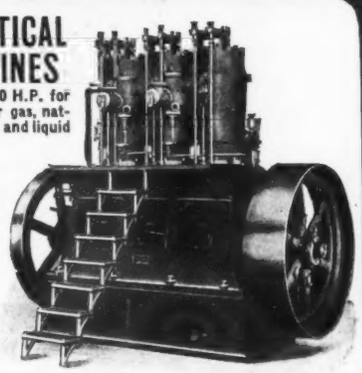
THE BRUCE-MERIAM-ABBOTT CO.,
1688-1692 Columbus Road,
CLEVELAND, OHIO.

PRODUCER
GAS
THE CHEAPEST POWER IN THE WORLD

GAS ENGINES, GAS PRODUCERS
COMPLETE PLANTS INSTALLED

BROOMELL, SCHMIDT & STEACY CO.,
YORK, PENNSYLVANIA.

FOOS VERTICAL ENGINES
20 to 500 H.P. for producer gas, natural gas and liquid fuels.



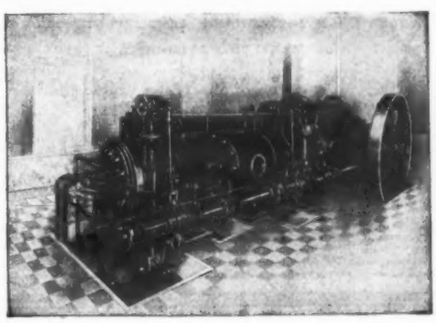
Foos Engines have a proven thermal efficiency of 28 per cent. and will pay for themselves in fuel saved.

Complete Power Plants, Waterworks and Electric Plants.

Ask for Catalog K,

The Foos Gas Engine Co.,
Springfield Ohio.
Largest Exclusive Gas Engine Plant in America.

DuBois Gas Engines
"The Improved Type."



The "DuBois" operates at lowest possible fuel expense on natural or city gas, gasolene or producer gas. Speed, gas, air and electric spark are adjustable while engine is running. Sizes 5 to 375 h. p.

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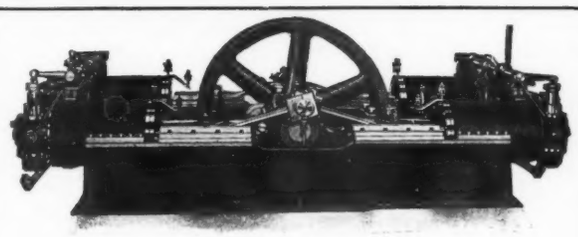
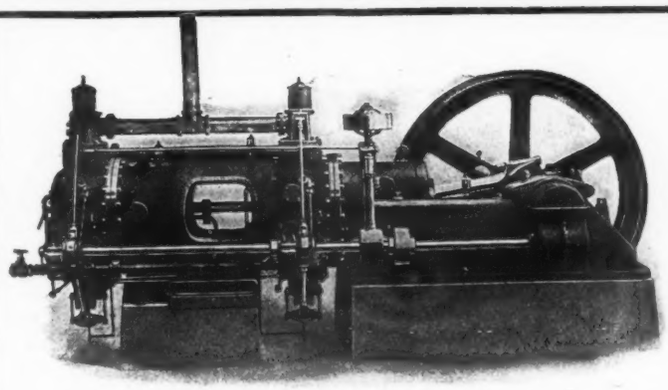
DUBOIS IRON WORKS
ESTABLISHED 1877.
805 BRADY ST., DUBOIS, PA.



For Heavy Duty

the Miller Gas Engine will easily prove itself superior to any other internal combustion engine on the market. It is built in 35, 50, 75, 100, 150 and 250 Horse Power sizes. Every part is designed with a view to strength, reliability and durability. The result is a harmonious combination of efficiency and economy. Catalog on request; write for it to-day.

THE MILLER IMPROVED GAS ENGINE CO.
SPRINGFIELD, OHIO, U. S. A.



WARREN GAS ENGINES
Horizontal and Vertical
Types up to 700 H. P.

NOT AN EXPERIMENT
Economy and Reliability Have Been Demonstrated by Actual Service

FULLY GUARANTEED
For All Street Railway, Electric Light and Power Requirements

STRUTHERS-WELLS COMPANY,
WARREN, PENNA.

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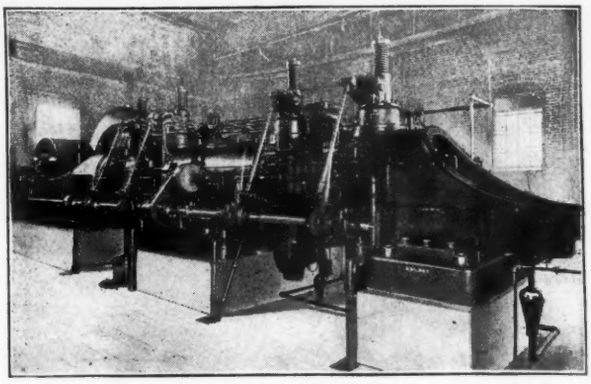
310 House Building.

# Westinghouse

## What the owner says about Westinghouse Horizontal Double-Acting Gas Engines



"I took occasion the other day to calibrate the rods on the 500 h.p. gas engines. I was very much pleased to know that the amount of wear on same was so small, that I was unable to detect it without the use of a micrometer gauge; this after nine months' operation and an output of 1,000,000 kilowatt hours."

Incidentally it may be of interest to note that during the nine months practically no repairs were necessary on the engines.

## The Westinghouse Machine Company

Steam Turbines, Steam Engines, Gas Engines, Gas Producers, Storage Batteries and the Roney Stoker

New York, 165 Broadway. Atlanta, Candler Building. St. Louis, Chemical Building. Denver, 512 McPhee Building.
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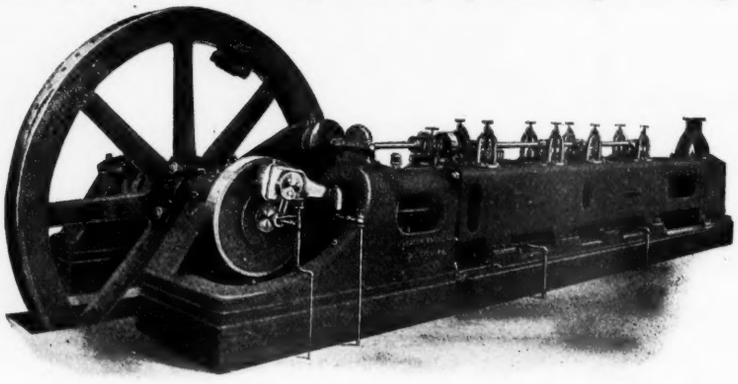
# A HIGH MECHANICAL EFFICIENCY

Due to simplicity of valve gear, balanced valves, properly constructed metallic packings, a perfected magnetically operated ignition system, along with a consistent distribution of metal gives the



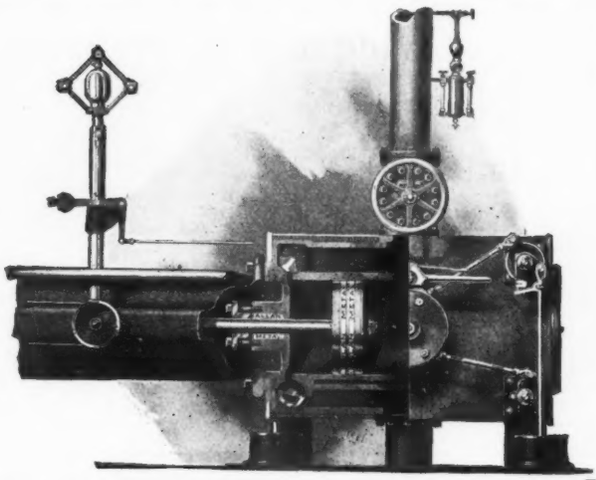
Riverside Heavy Duty Gas Driven Air or Gas Compressor. (Class F.)

## RIVERSIDE HEAVY DUTY GAS ENGINE

first place. It is wholly unlike any other engine. Built in twelve different types and seventy-two sizes. We also build a complete line of gas-driven air and gas compressors.

## RIVERSIDE ENGINE COMPANY, OIL CITY, PA.

New York City, 50 Church St. Pittsburg, Keenan Bldg. Fitchburg, Mass., The Brown-Russell Co. Atlanta, The W. E. Austin Co., Candler Bldg. Indianapolis, Mr. F. Louis Egan, 1130 Congress Ave. Cleveland, Holbeck Co., 924 Rockefeller Bldg.



## A Piston Faced With Allan Metal

overcomes excessive friction and wear.

Prevents scoring of cylinder and keeps same in a smooth and polished condition.

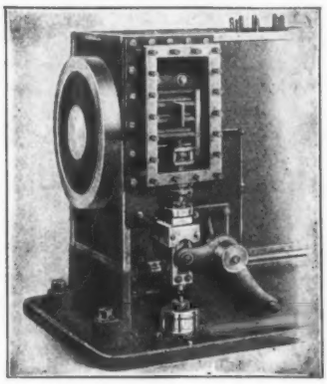
Allows space between rings for better distribution of cylinder lubrication.

For high and low pressure service.

As an Antifriction Metal it is unparalleled.

**A. ALLAN & SON,**
**482 Greenwich Street, New York.**

## Short, Direct Steam Passages



port areas of ample size, sound castings of specially selected close grained iron and numerous other exceptional features combine to make the Rollins Engine Cylinders worthy parts of the best engine that money can buy.

Catalog ?

**THE ROLLINS ENGINE COMPANY,**
**29 Mason Street, NASHUA, N. H.**
Pacific Coast Representatives—Armstrong-Kreling Machinery Co., San Francisco, Cal.

## ENGINE AND BOILER BARGAINS

ENGINES

| | |
|---|---|
| 20 x 42 Allis, Corliss | 16 x 32 Buckeye, Automatic |
| 18 x 42 Hamilton Corliss | 14 x 24 Atlas, Automatic |
| 18 x 36 Wright, Corliss | 13½ x 15 Taylor, Automatic |
| 14 x 24 Wright, Corliss | 12 x 18 Brownell, Automatic |
| 12 x 24 Wetherill, Corliss | 12 x 14 Green, Automatic |
| 10 x 30 Hamilton, Corliss | 12 x 12 N. Y. Safety, Automatic |

Also large assortment of Automatic and Throttling Engines of other sizes.

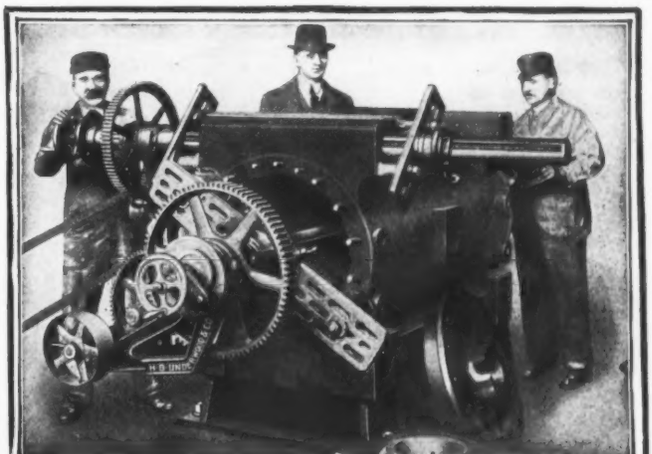
BOILERS

84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc.
Write for bargain list.

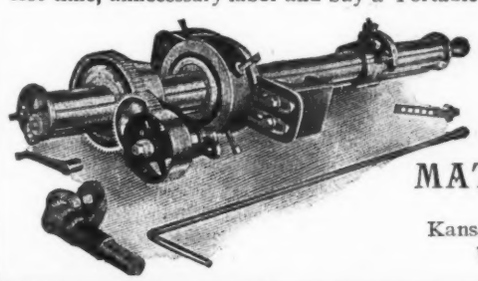
We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

**THE RANDLE MACHINERY CO.**
**1768 Powers St., CINCINNATI, OHIO.**



## PAYS FOR ITSELF

many times over every time it prevents shutting down to rebore a cylinder—think of express charges, freight charges, lost time, unnecessary labor and buy a Portable Boring Bar.



*WRITE!*

**HUGH MATHEWS**

Kansas City, Mo.
U. S. A.

## Engines Repaired Quickly, Cheaply and Satisfactory,

on the spot, between sunset and sunrise.

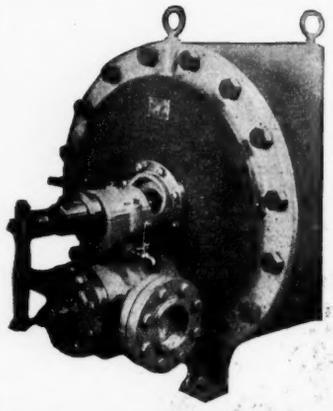
*Write.*

*AMMONIA COMPRESSORS INDICATED*

**H. B. Underwood & Co.,**

ESTABLISHED 1870

1027 Hamilton St. **Philadelphia, Pa., U. S. A.**



## Quick Delivery — Wide Range of Speed

TURBINE PUMPS for water works, condensers and boilers. Require less steam, attention, oil and space than direct acting piston pumps. Wide range of capacity and head.

TURBINE GENERATORS. Direct current 2 kw. to 150 kw., standard voltages. Alternating current 25 to 250 k. v. a., 60 cycle, standard voltages to 2200. Regulation close.

TURBINE BLOWERS for gas works, foundries and forge shops. No belts or reducing gears. Started or stopped quickly. Capacity up to 100,000 cu. ft. per minute. Pressure up to 16 ozs.

**NO OIL IN THE EXHAUST STEAM**

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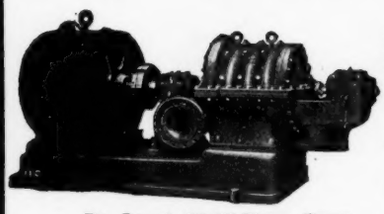
# DE LAVAL



Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electro Motor Centrifugal Pumps

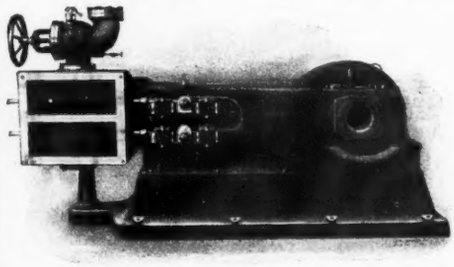
*Send for Catalog No. 20.*

De Laval Multi-Stage Pump.

**DE LAVAL STEAM TURBINE CO.,**
**Works and Sales Offices, TRENTON, N. J.**

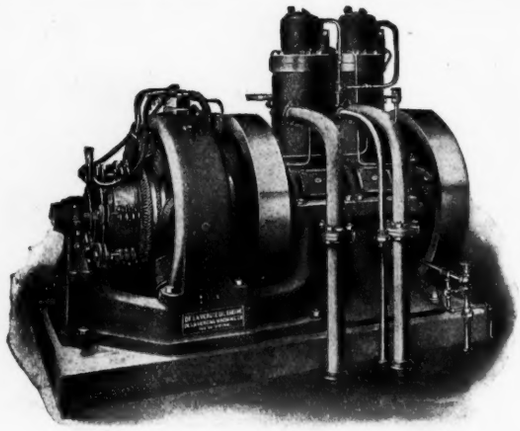
## For GENERATOR DRIVING

The Chuse Engines give a higher degree of efficiency, with a lower operating cost and less of your attention, than any other regardless of price.



*Write for Particulars.*

**CHUSE ENGINE & MFG. CO.**
**Mattoon, Illinois.**



For small and medium sized plants our

# OIL ENGINES

are cheaper, simpler, more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

**5315 H. P. used by Baldwin Locomotive Works**

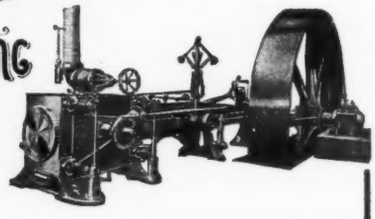
The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
"Hornsby-Akroyd" Horizontal Four-Cycle 2 1-2 to 250 H. P.

**DE LA VERGNE MACHINE CO.**

**Foot East 138th Street, NEW YORK.**

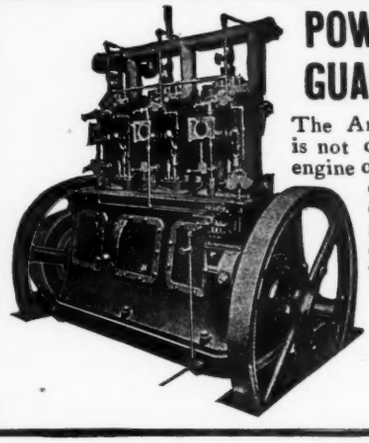
THE IMPROVED FISHKILL CORLISS ENGINE

BUILT BY THE FISHKILL LANDING MACHINE CO., FISHKILL ON HUDSON, N.Y.



**The most efficient and economical power for all purposes.**

**SEND FOR CATALOG.**

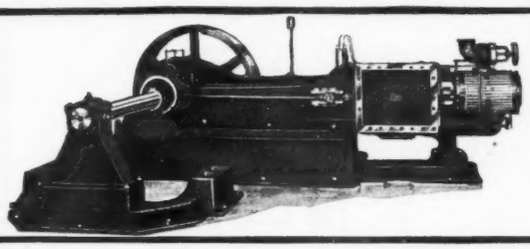


## POWER COSTS GUARANTEED

The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

*Write for Catalogue.*

**AMERICAN DIESEL ENGINE CO.**
**11 Broadway, N. Y.**



# Skinner Engines

have set a new mark for maintained economy, close regulation and perfection of lubrication.

**SKINNER ENGINE CO., - ERIE, PA.**

**FOR SALE**

One 50 H. P. Tandem Cylinder Gas Engine little used, at a bargain. Also 3 or 4—25, and 30 H. P. Gas Engines at a reduced price. Good as new.

**Ajax Iron Works, Corry, Pa.**

**MOUND TOOLS. FOR THE ENGINE ROOM.**

This cut represents our new set of 20 tools gotten up for use in the engine room. Strictly high-grade tools with all the good points of toolsmithing in their make-up. Conveniently arranged in finished Oak Case and every tool is guaranteed.

No. 20 Set of 20 Tools . . . $4.00.

Book "Engineers' Chums" free. Address Dept. B

**MOUND TOOL AND SCRAPER CO.**

1606-1608 N. BROADWAY, ST. LOUIS, U. S. A.

**REEVES ENGINES**

MAINTAIN THEIR ECONOMY AND SUPERIOR RUNNING QUALITIES.

**ASK ANY USER**

**REEVES ENGINE AND MACHINE CO., Trenton, N. J.**

# CORLISS ENGINES

Simple, condensing and compound, 50 H. P. to 2000 H. P. Complete steam power outfits for every service. Superior in workmanship and performance.

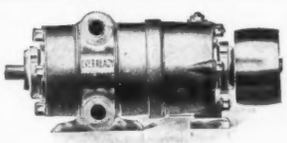
**THE BASS FOUNDRY & MACHINE COMPANY,**

FORT WAYNE, INDIANA.

We Manufacture

**AN ECONOMICAL AND DURABLE ROTARY ENGINE**

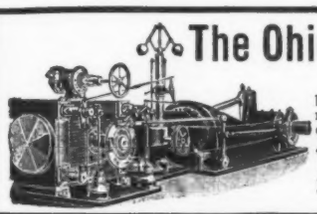
*Send for Catalogue.*



**Ball-Cooley Engineering Co.**

316 HUDSON ST., NEW YORK CITY and 159 GREEN ST., BOSTON.

**The Ohio Corliss Engine**



For hard work, heavy loads and high-speed, the Ohio shows close regulation and runs smoothly and quietly.

**THE GRIFFITH & WEDGE CO.**

Est. 1840. ZANESVILLE, OHIO

# YOURS On a Minute's Notice

**WE HAVE FOR IMMEDIATE DELIVERY:**

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h. p; wheel 14-ft. diameter by 48-inch face.

One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p; wheel 14-ft. diameter by 33-inch face.

The above are new engines.

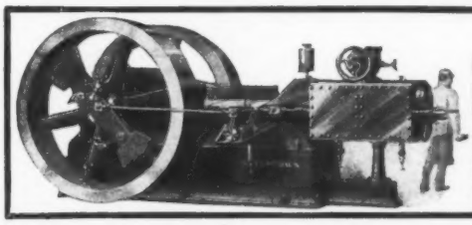
One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11 inches diameter. Wheel weighs 15,000 pounds.

Get busy and communicate with us.

**C. H. Brown Engine Co.,**

Incorporated

FITCHBURG, MASS.



**Good Engines**

for every power purpose. Ask for Catalog.

**Watertown Engine Co.,**

Watertown, N. Y.

# ALBERGER TANDEM GAS ENGINES

ACCURATE REGULATION FOR ELECTRIC SERVICE—AUTOMATIC CUT-OFF, AND RITES FLY-WHEEL GOVERNOR

**A.H.ALBERGER COMPANY**

45 TO 600 H.P. USING NATURAL GAS
35 TO 500 H.P. USING PRODUCER GAS

695-697 ELLICOTT SQ.
BUFFALO, N.Y.

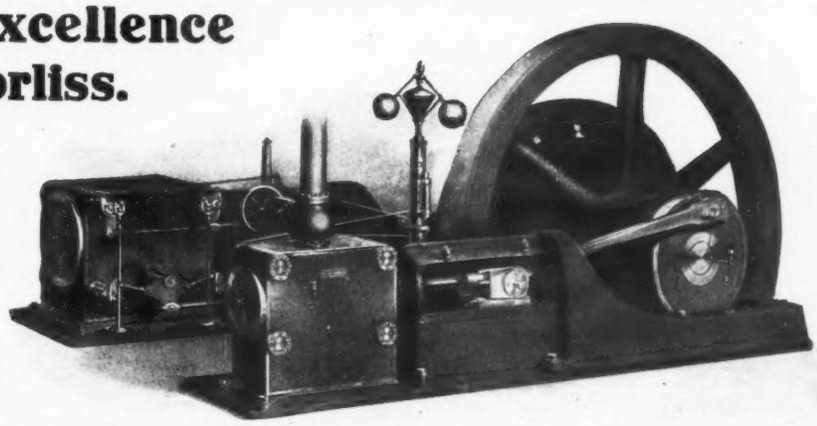
# A Standard of Excellence Is The Cooper Corliss.

Our Engines are unsurpassed for Rolling Mill and Direct Connected Electric Service. Built in a modern up-to-date Plant. Write!

**The C. & G. Cooper Co., Mt. Vernon, Ohio.**

Branch Offices:

New York, 918 Bowling Green Bldg.; Boston, 411 Weld Bldg.; Pittsburg, 604 Frick Bldg.; Philadelphia, Drexel Bldg.; Atlanta, 310 Candler Bldg.; Charlotte, N. C., Court House Square; Chicago, 1539 First Nat'l Bank Building.



# BUCKEYE ENGINE COMPANY,

**SALEM, OHIO**

**BUILDERS OF HIGH CLASS**

# STEAM AND GAS ENGINES

**HIGH IN DUTY, SUPERIOR IN REGULATION**

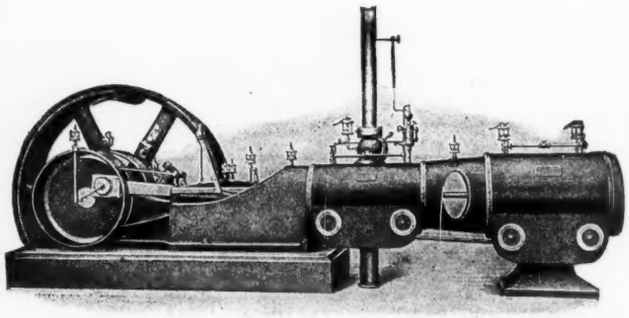
**AND**

**ABSOLUTELY RELIABLE**

**CORRESPOND WITH US BEFORE PURCHASING**

**CATALOGS ON APPLICATION**

# "RUSSELL ENGINES"



Four Valve Semi-Corliss—Single Valve Enclosed Self-Oiling and Open Types, Simple and Compound, Belted or Direct Connected, Designed Specially for heavy duty, economy and close regulation.

**The Russell Engine Co.,**

**Massillon, Ohio, U.S.A.**

# CORLISS ENGINES.

Simple, Tandem and Cross Compound

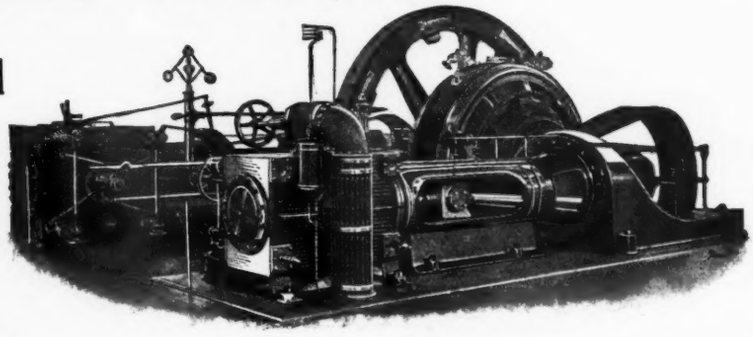
From 50 to 3000 H. P.

Heavy Duty or Girder Frame.

**ST. LOUIS IRON and MACHINE WORKS,**

**Main Office and Works, St. Louis, Mo.**

New York Office, 135 Broadway.



# McINTOSH, SEYMOUR & CO., Auburn, N. Y.

# ENGINES

**VERTICAL, HORIZONTAL.**

**BELTED, DIRECT COUPLED.**

**Simple, Compound. Triple Expansion.**

**New York:**
**McIntosh, Seymour & Co.**
**50 Church St.**

**San Francisco:**
**Charles C. Moore & Co.**
**99 First Street.**

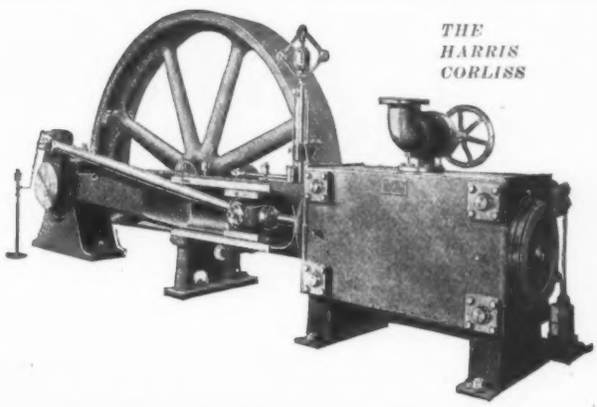
**Boston:**
**J. A. Grant & Co.**
**Tremont Bldg.**

# Every Day is Record Day

and any day's record with the HARRIS-CORLISS is worthy to compare with the best special tests of other engines. The difference in economy would justify a much larger difference in price.

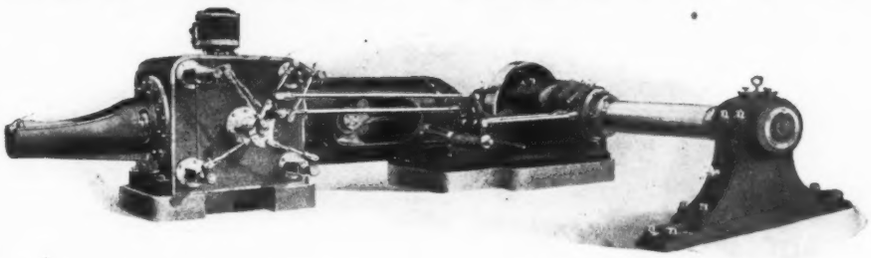
*Write for specifications.*

**Wm. A. Harris Steam Engine Company**
PROVIDENCE, R. I.



*THE HARRIS CORLISS*

# The Valve Travel Never Varies



**The Clark Heavy Duty Corliss Engine**

is unequalled for close regulation, low steam consumption and durability without repairs.

These advantages result from perfect valve seats, heavy duty bed with bored guide, extra large main bearings, and numerous other features for which write.

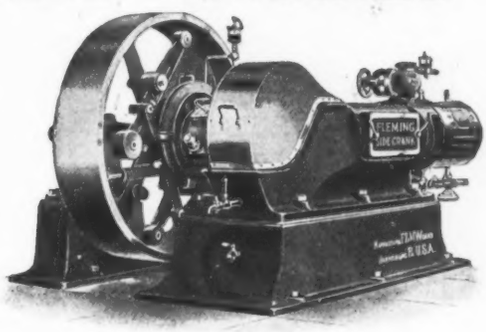
**Clark Brothers Company, - Belmont, N. Y.**

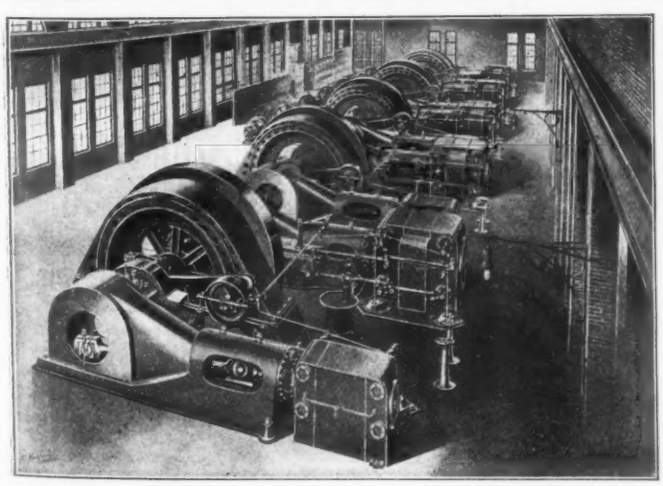
# FLEMING-HARRISBURG ENGINES

are known the world over for their satisfactory and economical operation in all kinds of diversified service—built

**Simple, Tandem and Cross Compound**
in both **Single and 4-Valve Types**

**Harrisburg Foundry and Machine Works,**
**Harrisburg, Pa., U. S. A.**
Selling Offices in all principal cities.





# Rice & Sargent Corliss Engines

ARE NOTED FOR

**Reliability, Economy, Overload Capacity and Speeds Higher than Other Corliss Types.**

*RESULT—Lowest Final Cost of Power*

The illustration shows RICE & SARGENT engines operating Alternating Current Generators in Parallel at 100 R.P.M.

The maximum capacity of the plant shown is 12000 H.P.

DESIGNED AND BUILT BY

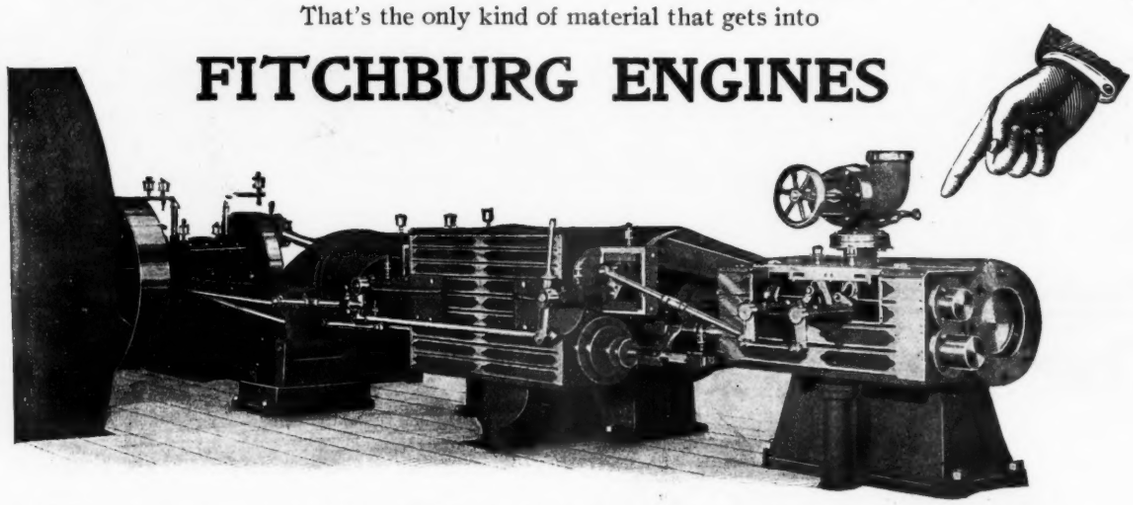
**PROVIDENCE ENGINEERING WORKS**

**Main Office and Works** **PROVIDENCE, R. I.**

# Too Good To Be Kept Out

That's the only kind of material that gets into

## FITCHBURG ENGINES

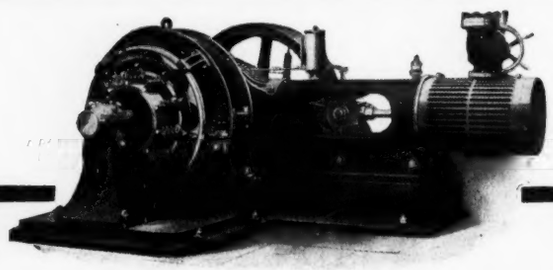


The same is true of the workmen who get into the Fitchburg shop. Ours is the only engine made that can be kept steam tight for 25 years on only one hour's work per year.

*CATALOG?*

**The Fitchburg Steam Engine Co., - Fitchburg, Mass.**

E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1501 Fisher Bldg., Chicago. Geo. H. Connor, 509 Mutual Life Bldg., Philadelphia.
W. C. Teas, Chattanooga, Tennessee. Western Trading Co., San Francisco.



# AFFINITIES

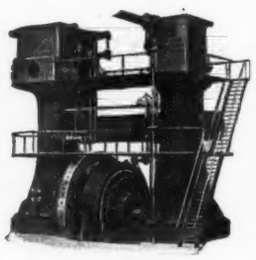
The Ridgway Dynamos and Engines are built expressly to run together. Each is a composite of perfect parts built to gauge, perfectly balanced and regulated.

Their harmonious operation results in record economy.

*Ask for Bulletins.*

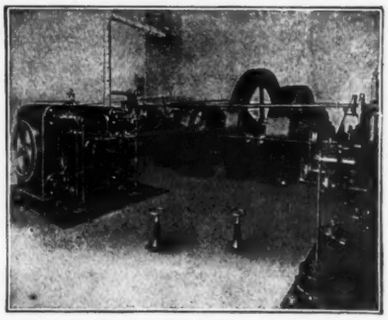
**Ridgway Dynamo & Engine Co.**
**Ridgway, Pa.**

**HEAVY DUTY**
**CORLISS**
**AND**
**Piston Valve Engines**



**Mesta Machine Company**
**Pittsburgh**

# Complete Power Plants.

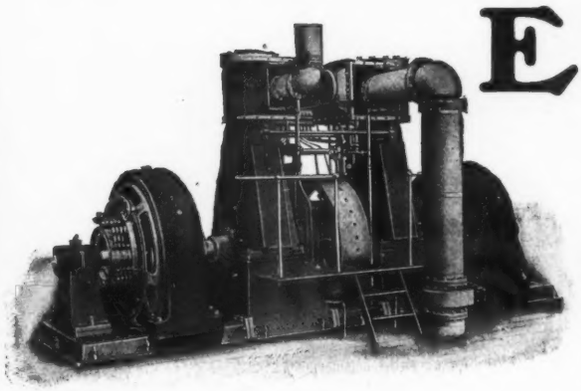


**The VILTER Mfg. Co.**
**854-894 Clinton St.**
**MILWAUKEE, WIS.**

**CORLISS ENGINES**

**ICE MACHINES**

# SHEPHERD ENGINES

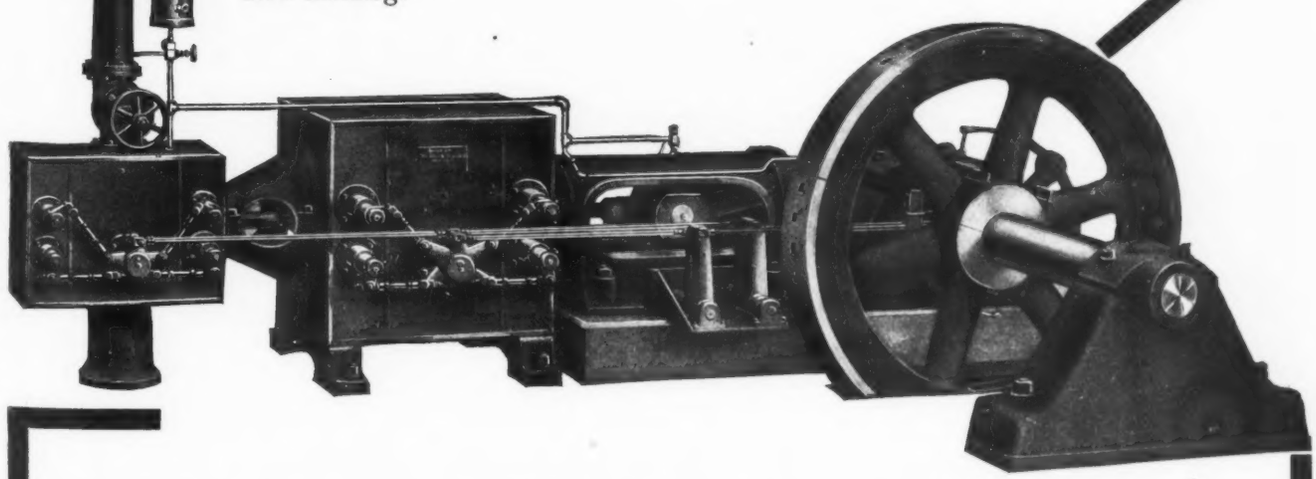


Not the purchase price, but what the engine will demand from your pocketbook in the future—its operating expenses—that's the point to consider. It's a point that's folly to overlook. Whatever satisfaction you gain in paying a low price soon vanishes before high operating expenses. It's almost incredible the extra dollars a poorly designed and cheaply constructed engine will require constantly to keep going. Those qualities that give an engine reputation; close regulation, simplicity, strength and reliability, are decidedly pronounced in a Shepherd. And they're the qualities—the chief qualities that make real economy of operation possible. The name SHEPHERD on an engine of any size from 10 to 2000 H. P. insures superior service at low cost. *Illustrated catalog free on request.*

**The SHEPHERD ENGINEERING CO.**
**WILLIAMSPORT, PA.**

## The Nearest Approach to STEAM ENGINE PERFECTION.

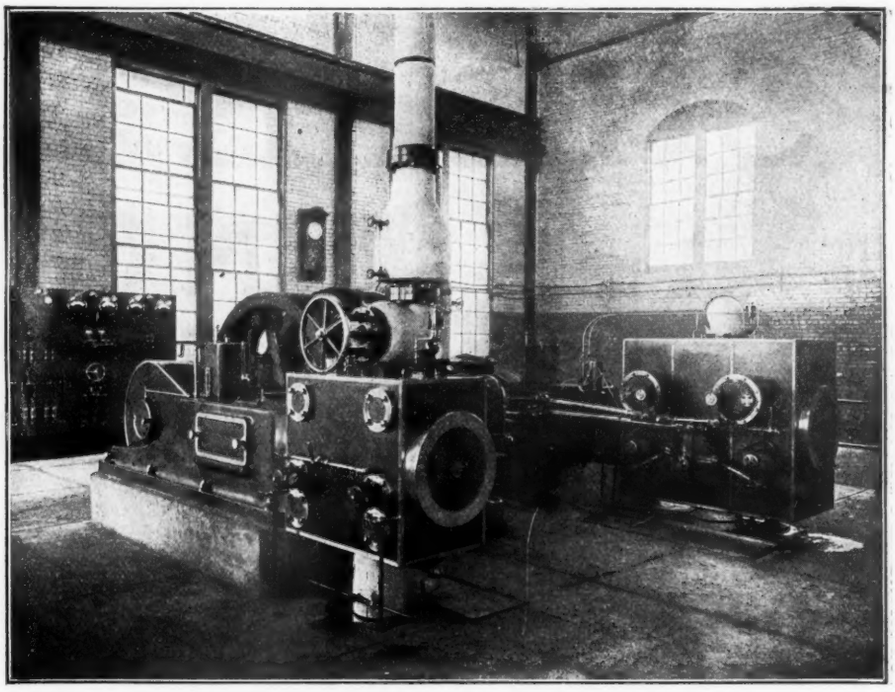
The Ballwood Engine is uniform in speed, silent in operation, with an unequalled economy. Write for illustrated descriptive catalog.



**THE BALL & WOOD CO., ELIZABETHPORT, N. J.**
New York Sales Office, 17 Battery Place. N.Y.C.

**Makers of Ballwood Welded Flanges.**

# THE BALL ENGINE CO., ERIE, PA.



Cross Compound Non-Releasing Valve Gear Corliss Engine
Direct Connected to Generator, in Dean Electric Co. Plant, Elyria, Ohio.

SALES OFFICES

NEW YORK, N. Y., 39 Cortlandt St.
L. COPPELSTON, Mgr.

CHICAGO, ILL., 1526 Monadnock Block.
W. A. KREIDER, Mgr.

BIRMINGHAM, ALA., 601 Brown-Marx Bldg.
H. W. CANNING, Mgr.

PHILADELPHIA, PA., 1001 Arcade Bldg.
H. P. PENFIELD, Mgr.

ST. LOUIS, MO., 1213 Chemical Bldg.
O. L. COLLINS, Mgr.

SEATTLE, WASH., 1112 American Bank Bldg.
J. C. CORBIN, Mgr.

# STEAM ENGINES

**George H. Corliss.** **Greene-Wheelock.**

# DIESEL ENGINES

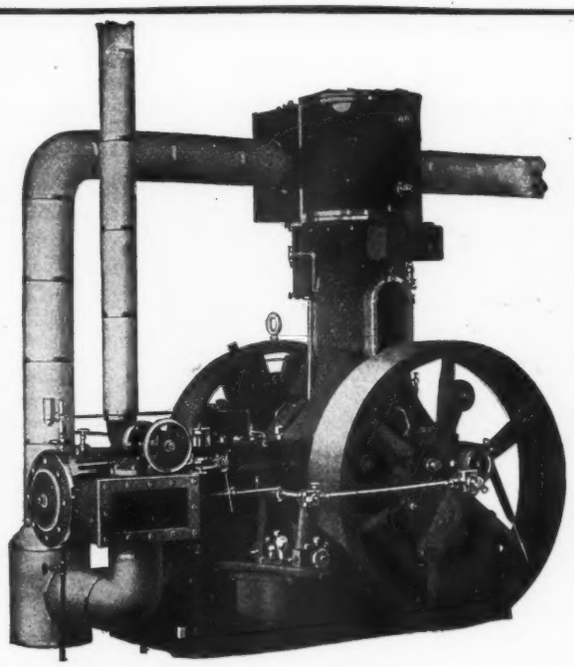
**Sole Builders For American Diesel Engine Co.**

# STEAM TURBINES

**Sole Builders For Wilkinson Steam Turbine Co.**

## American & British Mfg. Co.

General Offices—CORLISS WORKS. PROVIDENCE, R. I.



## A HIGH SPEED ENGINE WITHOUT HIGH SPEED FAULTS

Run an ordinary engine at high speed and there is apt to be trouble, perhaps from hot bearings, or from frequent breakdowns, or from pounding and vibration. In balancing an ordinary engine there are two horns to the dilemma. The to-and-fro movement of the reciprocating parts tends to shuffle the engine off its foundations. If the counterweight is made heavy enough to balance this, the centrifugal force of the weight at high speed may be so great as to make the engine jump up and down on the foundations. In any case it produces excessive wear on the bearings.

In meeting this situation we took the bull by the horns. We put two pistons at right angles to each other so that one counterweight could exactly balance the resultant of the horizontal and vertical forces in all positions.

The American-Ball Angle Compound engine is the result. Its smoothness in running at all speeds is phenomenal. Moreover, it has a practically uniform turning moment, requiring less fly-wheel weight, reducing friction losses and enabling alternators to run parallel without cross currents. Twice as much horsepower can be put on the same floor space and foundations. A stout concrete floor will do for foundation. Two light pistons, one vertical, make less friction and wear in the cylinder.

These are some of the results from one original step in design. We have also incorporated all the good features developed in building large numbers of simple and compound high-speed automatic engines.

**Our little booklet presents all this in a compact and readable shape. Send for a copy.**

**AMERICAN ENGINE CO.**

**22 RARITAN AVE., BOUND BROOK, N. J.**

No. 5



# Small Curtis Turbine Generators

The simplicity of the Curtis Turbine is not alone a feature of construction. It also contributes to valuable operating advantages. There are no internal wearing parts to cause a decrease in efficiency, after long periods of operation. Compare the view below of the working parts of the turbine with the corresponding parts of a steam engine and calculate the expense of piston packing, reboring cylinders, valve grinding and bearing linings for an engine which are avoided in the Curtis Turbine.

**Wheels and shaft of 75 kilowatt Curtis Turbine in position in lower half of wheel casing**

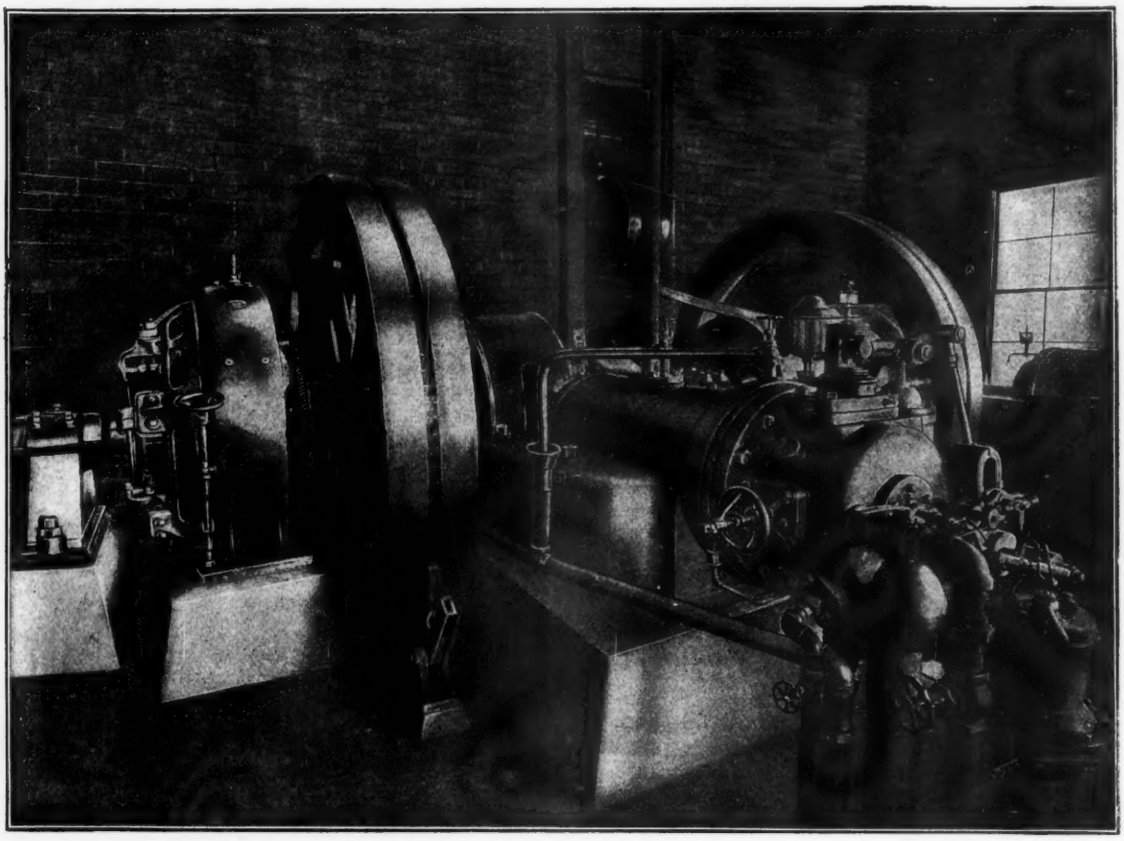
And remember that no injury is done if the Curtis Turbine is flooded with water while in operation, and that it may be brought up to speed ready to carry the load almost instantly without the warming-up, draining, etc., customary with the reciprocating steam engine.
If you need more power tell us what you have and we will tell you more about these small turbine sets.

*General Electric Company*

**Principal Office: SCHENECTADY, N. Y.**

**New York Office: 30 Church St.**
**Sales Offices in all large cities.**

1790



# Muenzel Gas Engine and Suction Producer Plant

The above cut shows one of the direct connected units in the Power Plant of the M. & St. L. R'y shops—where we have four different Engines.

"This Engine ran day and night without a single stop for 92 days—when shut down for examination was in perfect condition."—*From operator's report.*

*How about reliability?*

**Minneapolis Steel and Machinery Co.,**

**Minneapolis, Minn.**

# RELATIVE VALUES OF
# KEYSTONE GREASE
## AND HIGH GRADE OIL
## FOR LUBRICATING ANY MACHINE FOR A GIVEN TIME

## One Pound of KEYSTONE GREASE Equals 48 Pounds of Lubricating Oil

Our absolutely pure Grease has a natural body that enables every particle to do real lubricating—with no waste whatever. It has proven its tremendous superiority over the highest grade oils in every plant that has given it a trial. As shown in the above chart **Keystone Grease** lasts 48 times longer than oil. It reduces friction to almost nothing and saves repairs by providing perfect lubrication for all kinds of heavy or light machinery.

Look into the lubricating question—and investigate **"Keystone."**

KEYSTONE TRADE MARK REGISTERED U.S. PAT. OFF.

We wish to send to every engineer, absolutely free, express charges paid, a large trial can of **Keystone Grease,** a fine heavy brass grease cup and an engineer's collapsible lunch box. For details

See Our Advertisement On Page 3.

# Keystone Lubricating Company,

ADDRESS DEPT. B. **Philadelphia, Pa.**

New England Office—10 Oliver St., Boston, Mass.
New York City Office—96 Warren St.
Southern Office—610 Chartres St., New Orleans, La.
Chicago Office—1210 Tacoma Bldg.
Northwestern Office and Warehouse—502 McPhee Bldg., Denver, Col.
San Francisco Office and Warehouse—268 Market St.

**Murray Corliss Engines Save Steam, Steam is Coal and Coal is Cash.**

## *To the Engineer*

*In Charge of a Small Steam Plant:—*

*You are probably running a slide-valve engine, or one of the so-called automatics that perhaps requires, after a few years' use, as much steam; and you may be shoveling the coal yourself. You know of the economy of the Corliss engine, but think that you cannot get one small enough for your plant. You have studied the Corliss engine builders' catalogues and found all of the engines too large and have concluded that it was necessary to go on wasting coal.*

*We have thought about you for some time, but have been too busy to help you out. However, the slackening up of trade has given us a chance to design a*

*Little Murray Corliss Engine.*

*This will be built in several sizes to meet various conditions. Just tell the Boss that this new engine will save you from shoveling one ton of coal out of every two or three, and that it will save him one good dollar out of every two or three that he is paying the coal man.*

*Yours sincerely,*

*The Murray Iron Works Co.,*
(*Incorporated Feb.* 1, 1870)

*Burlington, Iowa.*

**There is Only One Engine and That is the Corliss.**
**There is Only One Corliss and That is the Murray.**